RECORDS
OF
THE GEOLOGICAL SURVEY OF INDIA.

Part I.] 1915. **[February.**

NEW SIWALIK PRIMATES AND THEIR BEARING ON THE QUESTION OF THE EVOLUTION OF MAN AND THE ANTHROPOIDEA.

BY GUY E. PILGRIM, D.SC., F.G.S., *Officiating Superintendent, Geological Survey of India.*

(With Plates 1 to 4 and two text figures.)

SOME of the material, now described, was in my hands as long ago as 1910 and formed the basis for the establishment of one new genus, *Sivapithecus*, and two new species, *Dryopithecus punjabicus* and *Semnopithecus asnoti*. Time did not then allow me to do more than publish the briefest notices of these forms[1]. Further material has since been from time to time discovered, which abundantly confirms my first conclusions, and the time seems now to have arrived, when a full and detailed account of the whole should be published. The material now at my disposal obliges me to establish two additional species of *Dryopithecus*, *D. chinjiensis* and *D. giganteus*, and another new genus, *Palæosimia*, with the specific name of *rugosidens*.

When Lydekker investigated the Indian fossil Primates between the years 1879 and 1885, very little was known about the age of the beds which had yielded them, or of their correlation with the mammal horizons of Europe. Fresh facts on this subject have accumulated during the last six years, and the results so far obtained have been summarised by the present writer[2] in a paper published in 1913.

---

[1] Pilgrim, Notices of new mammalian genera and species from the Tertiaries of India, *Rec. Geol. Surv. India*, XL, p. 63 (1910).

[2] Pilgrim, The correlation of the Siwaliks with mammal horizons of Europe, *Rec. Geol. Surv. India*, XLIII, p. 264 (1913).

Although the exact locality, from which the specimens, belonging to the earlier collections, came, is still doubtful, yet the following is the most probable horizon of the various Indian fossil Primates now known :—

Presbytis (*Semnopithecus*) *entellus* (?)	Karnul caves	Pleistocene.
Simia cf. satyrus	Upper Siwalik (upper zones.)	Upper Pliocene.
Papio falconeri Lyd.		
Papio subhimalayanus Meyer		
Presbytis (*Semnopithecus*) *palæindicus* Lyd.		
Macacus (?) *sivalensis* Lyd.	Dhok Pathan zone.	Pontian.
Cercopithecus (?) *asnoti* Pilg.		
Palæopithecus sivalensis Lyd.		
Dryopithecus giganteus Pilg.	Nagri zone	Lower Pontian.
Dryopithecus punjabicus Pilg.	Nagri and Chinji zones.	Sarmatian.
Sivapithecus indicus Pilg.		
Palæosimia rugosidens Pilg.	Chinji zone	Sarmatian.
Dryopithecus chinjiensis Pilg.		

The most interesting features connected with the recent discoveries are:—

1. The evidence afforded of the widespread distribution of the genus *Dryopithecus*, which supports the theory, already prevalent, as to the close affinity of African and Asiatic anthropoid apes with the genus *Dryopithecus*.
2. The knowledge of the complete upper dentition of *Dryopithecus*, now for the first time discovered, and hitherto known only by isolated molars.
3. The possession by the genus *Sivapithecus* of characters, which more nearly resemble those of Man than is the case in any other genus of anthropoid living or fossil, except perhaps, the Pleistocene *Pithecanthropus* and *Eoanthropus*. The occurrence of such a type as far back as the sarmatian is strong evidence that the line of Man's descent diverged from that of the other anthropoids at a very early date. The co-existence of these essentially human characters with others which are no less certainly primitive, though they have persisted in the apes, and have even been retained in some small degree by early specimens

of mankind, points to some closely allied form to *Sivapathecus indicus* as the direct ancestor of Man.

In that case it would seem that we may quite reasonably anticipate the discovery of true Man, at least in Pliocene strata, since the differences between Palaeolithic Man and his assumed sarmatian predecessor are not so great as to render it unlikely that the interval of time occupied by the pontian stage should be sufficient to obliterate them from a generic point of view.

4. The characters common to the Gibbon and *Sivapithecus* and not shared by the other living apes, point to *Sivapithecus*, and therefore Man, being an early offshoot from the Gibbon line.

The evidence for these conclusions is amplified and discussed at the end of the present paper. We shall be in a better position to estimate its value when the detailed description of the specimens has been given. I shall, therefore, proceed at once to the systematic portion, in which the *Cercopithecidae* will be treated separately to the anthropoid apes.

CERCOPITHECIDAE

CERCOPITHECUS (?) ASNOTI Pilgrim

PLATE I, FIGS. 1—3.

1910. *Semnopithecus asnoti* Pilgrim, Notices of new mammalian genera and species from the Tertiaries of India, *Rec. Geol. Surv. India*, vol. XL, page 64.

The fragment, upon which this species was founded, was very briefly noticed by the writer in 1910 in the paper quoted above. It was there referred, on exceedingly feeble evidence, to the genus *Semnopithecus* (now to be known as *Presbytis* by virtue of the laws of priority of nomenclature), and the specific name of *asnoti* was given to it.

I may preface my remarks by suggesting the extreme probability that the fragment is generically indeterminable. It consists only of a portion of the immature right maxilla of a Cercopithecid monkey (Ind. Mus. D. 120), containing the first molar (unworn), the last milk molar (greatly worn) and the last premolar, which has been developed out of its position *in alveolo*, by cutting away the side of the jaw beneath the last milk molar.

A left maxilla (Ind. Mus. D. 121), containing two unworn molariform teeth, the larger of which is identical in size, shape and structure with the milk molar in the last mentioned specimen, probably belongs to a very immature individual of the same species, the two teeth it contains being then mm^3 and mm^4.

These specimens were collected by Sub-Assistant M. Vinayak Rao from the neighbourhood of the village of Hasnot, in the Salt Range area, and from the nature of the matrix were almost certainly derived from the Dhok Pathan zone of the Middle Siwaliks.

Another tooth (Ind. Mus. D. 182), exactly similar to the first molar in the type maxilla, was collected from a locality which is well known to me, about 1 mile north-east of Domeli railway station on the road to the village of Chakwa. This is situated nearly 20 miles to the north-east of Hasnot and its stratigraphical position is, undoubtedly, in the Dhok Pathan horizon.

The dimensions of these teeth are as follows :—

—		Ind. Mus. D. 120.	Ind. Mus. D. 121.	Ind. Mus. D. 182.
M^1	length	8·2	..	8·5
	breadth	8·0	..	7·4
	height	5·9	..	5·4
Mm^4	length	6·9	6·5	..
	breadth	7·0	6·7	..
	height	..	4·6	..
Pm^4	length	6·8	..	..
	breadth	6·8	..	..
	height	..	..	..
Mm^3	length	..	5·6	..
	breadth	..	5·5	..
	height	..	3·4	..

The four cusps of the molars, connected in pairs by exactly transverse ridges, and the shape of the premolar leave us in no doubt that we have to deal with a member of the Cercopithecidae.

Since, however, the teeth of the different genera belonging to this family are remarkably like one another, differences in the proportion, which the individual teeth bear to one another, form often the only means by which their dentition can be distinguished. In the absence of the two hinder molars we are debarred from such a comparison.

On the assumption that the specimen belonged to *Presbytis* (*Semnopithecus*), then the presence of the broad anterior shelf, projecting slightly on the external wall of m^1 as well as mm^4, afforded a marked difference from the corresponding teeth of any species of *Presbytis* known to me. This was indicated in my preliminary note on the specimen. This shelf is formed by the continuation of ridges which run forward from the two anterior cusps. In the present species the external portion of the shelf is separated from the external cusp by a furrow which runs vertically half way down the external wall of the crown.

I have since discovered that this feature is a constant character of the African genus *Cercopithecus*. It does not seem to be shared by *Macacus*, *Colobus*, *Cercocebus*, *Mesopithecus*, *Libypithecus* or *Dolichopithecus* any more than by *Presbytis*. In *Dolichopithecus*, indeed, such a shelf would appear to be altogether absent, the anterior cusps standing quite near the edge of the tooth[1]. On the other hand in that genus there is a distinct external cingulum, having no connection with the anterior cusps and situated nearer the base of the crown.

An additional point of distinction is afforded by the shape of pm^4, which had not been exposed when I wrote my preliminary note. This tooth in the specimen under consideration is characterized by the long distance from the summit of the transverse crest to the posterior border of the tooth, as compared with that between the summit and the anterior border. In *Macacus* the two distances are the same and the tooth as a whole is rather short. In *Presbytis* the tooth is longer than in *Macacus*, and the posterior is longer in proportion to the anterior part of the tooth, but not so markedly so as in the Hasnot tooth. Neither *Dolichopithecus* nor *Mesopithecus* show this feature. On the contrary something of the same kind is found in *Cercopithecus*.

---

[1] Depéret, Les animaux pliocènes du Roussillon, *Pal. Mém. Soc. Géol. France*, 3 (1890) p. 11.

In weighing the evidence in favour of assigning the specimen to one genus rather than to another, I consider that we are bound to take account of these two features, trifling though they may seem, which it shares in common with the genus *Cercopithecus*, but, as far as I am aware, with no other. Supposing it were ancestral to the living African monkeys, which are placed in *Cercopithecus*, we should, perhaps, hardly expect it to have the large dimensions which are actually the case. Consequently, it is more probable that it represents a lateral branch from the *Cercopithecus* stock. In calling the specimen *Cercopithecus* (?), I, therefore, only mean to draw attention to what seem to be its most probable affinities, while admitting the likelihood that more complete material would show it to be distinct generically from *Cercopithecus*. The pontian age of the Hasnot specimen would indeed *a priori* incline us to a belief that its genus is not the same as the recent one, but it is necessary to await further material before giving effect to such a belief.

The geological significance of such an affinity with an African type in an Indian pontian species is noteworthy, in so far as it points to a period in the lower Miocene, when free intercommunication existed between the two continents. From a species, which was then common to the two areas, may have sprung on the one hand the modern African *Cercopithecus* and on the other Indian forms, of which this pontian species may be the first representative that has so far come to sight.

The fauna of the lower Miocene beds of the Bugti hills in Baluchistan[1] affords the best proof at present known of the close similarity at that geological period between the mammalian faunæ of India and Africa.

MACACUS (?) cf. SIVALENSIS, Lydekker

PLATE I, FIG. 4.

1878. *Macacus sivalensis* Lydekker, Notices of Siwalik Mammals, *Rec. Geol. Surv. India*, vol. XI, p. 66.

1886. *Macacus sivalensis*, Lydekker, Indian Tertiary and Post Tertiary Vertebrata, *Pal. Indica*, series 10, vol. IV, p. 5.

In 1878 Lydekker described under the name of *Macacus sivalensis* two fragments of maxillæ belonging to a Cercopithecid monkey, which were obtained by Theobald in the neighbourhood of the village of Hasnot in the Salt Range. From the character of the matrix still left on the specimens, there is little doubt that they were derived from the Dhok Pathan horizon of the Middle Siwaliks.

---

[1] Pilgrim, The Vertebrate fauna of the Gaj series in the Bugti hills and the Punjab, *Pal. Indica*, new series, vol. IV, mem. 2 (1912), pp. 1—83.

I suppose the author of the species would be the first to admit the possibility that more abundant material would oblige us to separate it generically from the living genus. He, however, has adduced arguments which render it probable that the affinities of these maxillæ lie with *Macacus*, and it is, therefore, obviously unreasonable to refer them to any other genus, though one may be allowed to regard the reference as provisional.

A few years ago Sub-Assistant M. Vinayak Rao obtained from the middle Siwaliks of Hasnot a fragment of the right mandibular ramus of a Cercopithecid monkey (Ind. Mus. D. 184), which is the subject of the present notice. It is figured in Plate I, fig. 4, and contains two perfect, well worn, molariform teeth, of which the smaller is in a more advanced state of wear than the larger. Behind the latter is the alveolus of another double-rooted tooth, and on the other side of these are the alveoli of two roots pointing to the former existence of at least one tooth, as large or larger than the one behind it, forming a slight curve with the hinder three. Immediately beneath the anterior margin of the smaller of the two perfect teeth, a sharp curve may be noticed in the lower edge of the ramus, which evidently marks the beginning of the symphysis. Behind this point, the side of the ramus drops almost vertically from the base of the tooth crowns to the lower edge of the ramus, without any bulge or ledge such as is often present on the inner side of the mandibles of monkeys. On the outer side, the mental foramen is visible 7·3 mm. from the base of the ramus, beneath the alveolus of the foremost of the four teeth, of which more or less distinct traces are left.

It may be gathered from this description that there can be no doubt that the dentition in this mandible is the permanent one, which is confirmed by the absence of any permanent premolars in the jaw below the two teeth which are preserved. The latter are therefore m_1 and m_2 and the tooth in the front of the jaw is pm_4.

The dimensions in millimetres of the mandible and of the individual teeth are as follows:—

Thickness of ramus beneath m_2		6·8
Depth of mandible below m_1		18·3
M_2	length	6·6
	breadth	5·9
M_1	length	5·8
	breadth	5·2
Approximate length of pm_4		7·2

On comparing this with the maxilla of *Macacus sivalensis*, figured by Lydekker, it is evident that the animal to which it belonged must have been almost of the same size. Further, the proportionate dimensions of the teeth are identical, so far as can be gathered, with those of the corresponding upper teeth of Lydekker's specimen, so that, other things being equal, a provisional reference to the species *Macacus sivalensis* is reasonable, since the specimens came from the same locality and horizon.

The most striking characters of this mandible are its depth and slenderness. These eminently characterize *Macacus* as distinguished from *Presbytis*. I am unable, however, to find that these characters enable us to distinguish it from *Cercopithecus*.

Some significance may be found in the apparent narrowness of the shelf in front of the anterior crest of the molars. This is a character of the genus *Dolichopithecus* as seen in the species *D. ruscinensis* from the Pliocene of Rousillon[1]. It is however much more pronounced in that genus. The advanced state of wear of the molars in the present mandible tends to cause the anterior cusps to run into this shelf and so appear nearer the margin than is really the case. The actual breadth of this shelf is probably almost the same as in the upper molars of the maxilla of *Macacus sivalensis*, in which it is narrower than in many macacques and decidedly more so than in the genus *Cercopithecus*.

A cingulum at the antero-external corner of m_2 and in the middle, externally, between the two crests, is similar to that which is present in *Dolichopithecus*. I have, however, seen a similar cingulum in specimens of *Macacus nemestrinus*.

The long alveolus of pm_4 in the Hasnot mandible points to a tooth which is rather longer than is usually the case in *Macacus*, and is more like pm_4 of *Dolichopithecus*.

---

[1] Déperet, l. c.

In conclusion, I have very little hesitation in referring this mandible and the maxilla from Hasnot, described by Lydekker, to the same species, and there seems no justification for removing them from the genus in which Lydekker placed the latter. The species may be regarded as showing features which indicate some affinity with the European Pliocene genus, *Dolichopithecus.*

SIMIIDAE

DRYOPITHECUS PUNJABICUS, Pilgrim

PLATE I, FIGS. 5, 6. PLATE II, FIGS. 4, 5. PLATE III.

1910. *Dryopithecus punjabicus*, Pilgrim, Notices of new mammalian genera and species from the Tertiaries of India, *Rec. Geol. Surv. India*, XL, p. 63.

1913. *Dryopithecus indicus* (lapsus calami), Pilgrim, The correlation of the Siwaliks with mammal horizons of Europe, *Rec. Geol. Surv. India*, XLIII, p. 311.

1913. *Palæopithecus* sp. Pilgrim, The correlation of the Siwaliks with mammal horizons of Europe, *Rec. Geol. Surv. India*, XLIII, p. 320.

The types of the present species are portions of the right and left ramus of the same mandible, the former containing m_3 with half the broken crown of m_2 and the latter m_2 with the broken crown of m_3. The specimens were found near the village of Chinji by Sub-Assistant Vinayak Rao, and though their exact locality has not been recorded, there seems very little doubt that they came from the Chinji zone of the Lower Siwaliks. There is some ground for supposing that they occurred at the very summit of that zone, partly because the matrix attached to them consisted of a hard reddish clay, free from concretions and similar to a fossiliferous clay, which is known to occur to the west of Chinji, near the boundary between the Lower and Middle Siwaliks, partly, also, because the maxilla found at Haritalyangar in the Simla Hills, which seems almost certainly to belong to the same species as the mandible, occurs in beds, which are known both by their fauna as well as their stratigraphical position to be newer than the Chinji zone, though they represent a low horizon of the Middle Siwaliks, to which the name of the Nagri zone has been given[1].

The species may therefore be referred in terms of European geological horizons, either to the upper sarmatian or the lowest pontian.

---

[1] Pilgrim, The correlation of the Siwaliks with mammal horizons of Europe, *Rec. Geol. Surv. India*, XLIII, pp. 270, 319.

Mandible.

The mandible, evidently, did not belong to an old animal, as m_3 is half concealed, in side view, by the ascending ramus, while this tooth is inclined at a slight angle to the one in front of it. The breadth of the ramus at m_3 is considerable —19·8 mm. The depth at m_2 is only 23·4 mm., but might no doubt have increased a little as the animal got older. As the ramus is broken off immediately in front of m_2, it is impossible to perceive if the depth of jaw increased anteriorly as in *Dryopithecus fontani.*

Last lower molar.—The dimensions of this tooth are as follows: length 12·5 mm., breadth 10·4, height 6·7. It is thus longer than broad, its greatest breadth being near the front end, whence the sides of the tooth converge backward to a rather narrow hinder tip, so that the general shape of the tooth might almost be described as sub-triangular, differing in this way from *Dryopithecus rhenanus,* but still more from *D. fontani* and *D. darwini.* The inner side of the crown descends steeply to the base, but the outer side less steeply, still by no means so gradually as in *D. darwini.* From both edges the slope towards the centrum of the tooth is extremely gentle. The five main cusps of the anthropoid lower molar are well marked, though, as in *Dryopithecus* generally, they are not high. The least worn and therefore the highest is the metaconid. The entoconid is smaller and lower than the metaconid. The protoconid and hypoconid are about equal in size and height. The mesoconid is both smaller and lower than either of the other two outer cusps. These three outer cusps are arranged in a curve, the hypoconid being situated more inwardly than the protoconid, and the mesoconid more so than either. The entoconid also lies nearer the centrum than the metaconid, so that the tooth tapers symmetrically.

Besides the main cusps there are two secondary cusps, which may be distinguished from the numerous swellings on the main cusps by the fact that fairly deep furrows running from the edge of the crown to the centrum delimit them from the five main cusps. These occur between the metaconid and the entoconid and between the entoconid and the mesoconid.

The main furrows, which separate the cusps, already mentioned, from one another, are precisely similar to those which Abel[1] has described so fully in the case of *Dryopithecus darwini.* As in the case of that species, the furrows between the three outer cusps only descend on the external wall of the tooth as far as a cingulum, which unites the cusps in question at rather less than half the distance from the cusp summit to the base of the crown. Here they dichotomize within the cingulum. On the other hand, the furrow between the entoconid and the secondary cusp which intervenes between it and the metaconid, runs right down the wall to the base of the crown. The furrow, however, which separates this secondary cusp from the metaconid is very faintly marked on the internal wall of the tooth. The remaining furrows, which are very numerous, are naturally associated with and equal in number to the various enamel ridges, and their course, where necessary, will be described in connection with the latter.

---

[1] Abel, Zwei neue Menschenaffen aus den Leithakalkbildungen des Wiener Beckens, *Sitz. kais. Akad. Wiss. Wien* CXI, Abt. 1 (1902) p. 1185.

These enamel folds are much more plainly to be seen on the inner side than on the outer side of the tooth, and are especially well marked on the metaconid. If, however, the outer cusps were less worn, there is no reason to suppose that the folds would be any shallower or less numerous. Both protoconid and metaconid send a strong crest obliquely to the front edge of the tooth, which is raised into a somewhat weaker ridge, behind which is a hollow. Another pair of ridges run from protoconid and metaconid towards one another, curling round into the just mentioned hollow. There are no less than four other folds on the sides of the metaconid. One of these produces a cusp, visible in side view on the inner side of the tooth and separated from the main cusp of the metaconid by a deep furrow, which starting from the edge runs towards the centrum. It soon dichotomizes and its branches run into the furrow, which separates the metaconid from its secondary cusp. The two remaining folds, of the four mentioned above, produce two ridges, which start some way down from the summit of the metaconid and run as far as the centrum. The anterior secondary cusp is also divided by one fairly strong and two weak furrows, running towards the centrum. Similar furrows, but much more feebly marked, are to be seen on the entoconid; traces of these can also be seen as furrows on the external wall of the tooth. Both the hypoconid and the mesoconid are too much worn to show any very distinct trace of folding.

Beyond the folds mentioned and a few others of limited extent, but all of which are visible to the naked eye, there is no trace of the fine rugosity with which the entire surface as well as the sides of the tooth in *Dryopithecus darwini* would appear to be covered.

On the contrary the surface of the tooth, even on the little worn metaconid, is quite smooth and polished between the various furrows.

The cingulum still remains to be mentioned. This exists only in the form of a broad shelf or ridge, which links the bases of the protoconid and hypoconid and to a smaller extent of the hypoconid and mesoconid. It does not extend beyond these limits; there is consequently no trace of the cingulum which in *Dryopithecus darwini* goes right round the antero-external angle of the tooth.

The hinder root of this tooth is strongly produced backward. There is a distinct oval polished face on the front wall of the tooth caused by the contact against it of the tooth in front.

Second lower molar.—This tooth is shorter than m_3, but broader in proportion, its dimensions being, length 11·6 mm., breadth 9·9 mm., height 5·4 mm. It is much more worn than m_3, and therefore the various folds, which are plainly visible in that tooth, are either very indistinctly so or are even entirely effaced in this. It does not possess the tapering shape of m_3, because the hypoconid is not nearer the centrum than the protoconid nor the entoconid than the metaconid. Thus the sides of the tooth are parallel. The mesoconid is, however, strongly displaced inward, so that the hinder end of the tooth is narrower than the rest of it, but lacks the symmetry of m_3. The secondary cusp between the entoconid and the mesoconid is very weak; in consequence, the hollow at the hinder end of the tooth is much more pronounced. The cingulum, linking together the bases of the protoconid and hypoconid and of the hypoconid and mesoconid is quite distinct.

A comparison of these two molars with those assigned to one or other of the three previously known species of *Dryopithecus* leaves no doubt in my mind as to the propriety of referring this mandible to the same genus. From Man, as well as from each of the living genera of anthropoid apes, *Dryopithecus* differs in the greater excess of length of m_3 over m_2. This is shown in the table on page 72.

From Man, the Chimpanzee, Orang, Gorilla and also from the fossil genus *Sivapithecus*, the molars of *Dryopithecus* differ by being less broad in relation to their length. This is rendered clearer by the breadth indices tabulated on page 70.

The hindermost cusp, mesoconid, is more strongly developed in *Dryopithecus* than in Man, the Gibbon, Chimpanzee and Orang. This weakness of the mesoconid is especially noticeable in m_3; in fact in the genera mentioned the mesoconid in m_3 is often altogether wanting.

The folds or wrinkles on the surface of the crowns of the teeth offer a means of distinction, although it seems likely that this is often a character which varies within the same genus according to its stage of development, and may, therefore, only be of specific importance. Thus, although the teeth of Caucasian man are not characterized by more than a few strong wrinkles, those of the fossil man[1] of Krapina and some of the lower races have the surfaces of the molars rather richly covered by them. Moreover, the wear of individual fossil specimens may easily deceive one as to the strength of the feature in question. Nevertheless, their strong development in the Orang distinguishes that genus not only from *Dryopithecus* but also from every other so far described. Equally the absence of wrinkles distinguishes the Gibbon as well as *Pliopithecus.* The folding of the enamel in *Dryopithecus* is very much less in intensity and frequency than in the Orang. The wrinkles in the Chimpanzee are often numerous but are very much finer than those of *Dryopithecus.* The Gorilla has sometimes very numerous and very strong folds on the molar surfaces. In Man, as observed before, the wrinkling appears to be variable, but the folds, though occasionally as strong or even stronger than in *Dryopithecus*, are not so numerous. In *Sivapithecus* the folding of the enamel is, like Man, coarser, but less frequent than in *Dryopithecus. Neopithecus brancoi* has much feebler wrinkles. Moreover it is distinguished from *Dryopithecus* by the much greater length of m_3.

Each one of the distinctions enumerated above is as applicable to the teeth under consideration as it is to *Dryopithecus.* They agree in every detail relating to the arrangement of the cusps and the folding of the enamel, with the lower molars of *Dryopithecus rhenanus*, as described and figured by Schlosser[2] and to a smaller extent with *Dryopithecus darwini* as described and figured by Abel[3]. I am quite unable, therefore, to refer the Punjab mandible to any other genus. I may, however, point out some additional features, in which my specimen may be distinguished from certain genera which approach it somewhat nearly in regard to the characters already detailed. Thus, the breadth index of the Gorilla sometimes does not exceed that of these teeth by much, while the folding is sometimes equally intense. The Gorilla is, however, easily distinguished by the exceedingly deep furrows which separate the main cusps, apart from the inferior length of m_3 in relation to m_2. Besides the points already mentioned, *Sivapithecus* differs by the higher cusps, the complete absence of a cingulum and the absence of secondary cusps.

---

[1] Gorjanovic-Kramberger, Der diluviale Mensch von Krapina, *Mitt. d. Anthrop. Gesells. Wien.*, XXXI, (1901), p. 190, pl. 2, 3.

[2] Schlosser, Beitrage zur Kenntniss der Saugethierreste aus den sud deutschen Bohnerzen, *Geol. u. Pal. Abhandl.* IX, (1902), pt. 2, p. 124.

[3] Abel, l. c., p. 1185.

A comparison with *Palæopithecus* is much more difficult, both because that genus is known only by the upper dentition, and also because the upper teeth are in such an advanced stage of wear that one cannot be certain either of the height of the cusps or of the nature of the enamel folding. The enamel is, however, very much thicker than in the mandible now before us, and it seems almost certain that the cusps in the unworn tooth of *Palæopithecus* were higher and more massive, while the wrinkling of the surface must have been of an altogether coarser type. It may, perhaps, be permissible to be influenced by the fact that the maxilla from Haritalyangar, to be described later, shows much clearer evidence of belonging to a different genus from *Palæopithecus*. On the other hand this maxilla exhibits a structure and details of sculpture so analogous to those of the lower molars from Chinji as to oblige me to assign them to the same species.

It remains now to see how this mandible differs from those which have hitherto been assigned to the genus *Dryopithecus*[2].

These may be said to be four in number, since, as Abel has emphasized, there are two distinct types of tooth referred to *D. fontani*, which in my opinion cannot be regarded as belonging to the same species, if even the same genus. These four species may be given as follows. *Droypithecus fontani*, type 1, Lartet. *D. fontani* type 2, Harlé[1], *D. rhenanus*, Pohlig, *D. darwini*, Abel. Of these *D. fontani*, type 2 has the greatest breadth index; next to this comes *D. darwini*, the breadth in the case of this species being due to the strong cingulum; *D. fontani* type 1 is the next highest, if Harlé's measurements were intended to be quite accurate; *D. punjabicus* comes next, while *D. rhenanus* is the lowest of all. These, however, form such a gradual series that no serious specific distinction can be based on this character, though it is interesting to observe that the order is in agreement with the supposed geological age of the different species.

---

[1] Harlé, Nouvelles pièces de Dryopithèque de Saint-Gaudens, *Bull. Soc., Géol., France*, (3) vol. XXVI, (1899) p. 304, pl. 4.

[2] I regret that Dr. A. Smith Woodward's paper on a lower jaw of *Dryopithecus fontani* from the upper Miocene of Lérida (Spain), published in the *Quart. Jour. Geol. Soc. Lond.*, vol. 70, p. 316, Dec. 1914, did not reach me in time to enable me to insert in the text any reference to this specimen or to Dr. Woodward's interesting remarks on the symphysis of *Dryopithecus*. These do not, however, appear to be inconsistent with the views on anthropoid evolution expressed by me in the latter portion of the present paper. The approximate dimensions of the molars in the Lérida specimen are included in the table on page 70.

It seems more important to observe that the length of m_3 as compared with m_2 is much greater in *D. punjabicus* than it is in *D. fontani*. This may be correlated with the taper shape of m_3 in *D. punjabicus*, due to the displacement towards the centrum both of the mesoconid as well as of the entoconid. M_3 of *D. fontani* is distinguished by being but little narrower in its posterior than in its anterior part, the three outer cusps forming a straight line. The displacement of the mesoconid towards the centrum is greatest in the species *D. rhenanus*; *D. darwini* and *D. punjabicus* are, perhaps, equal in this respect. On the other hand, m_3 in *D. rhenanus* does not taper in the symmetrical fashion so characteristic of *D. punjabicus*, because the entoconid in the former species is not displaced and is larger than in the latter. M_3 of *D. darwini* would, really, be far more like the Punjab species in this, were it not for its very broad and pronounced cingulum. This cingulum is present, but less strong in *D. fontani*, but is generally absent in *D. rhenanus*, though Schlosser[1] mentions a molar which shows what appears to be a connecting shelf between the protoconid and hypoconid similar to what occurs in *D. punjabicus*. It is perhaps permissible to emphasize the greater distinctness of this external cingular shelf between each of the two pairs of outer cusps in the Punjab species than in *D. rhenanus*. It would seem that *D. darwini* has fewer main foldings on its molar surface than *D. rhenanus*, but that it is characterized by the presence of a fine series of wrinkles indiscriminately over the surface of the tooth as well as on the sides. This type of wrinkling is absent from *D. punjabicus*, as it is from *D. rhenanus*. The Punjab species, however, seems to possess an equally strong and numerous series of large scale foldings, although differences in the stage of wear make it difficult to estimate the real strength of the foldings, especially when the actual specimens are not at hand for comparison. In *D. punjabicus* a series of rather deep furrows on the internal side of the tooth, which extend a short way down the wall of the tooth and in side view produce a distinct serrated margin on both the metaconid as well as the entoconid, appears to be especially characteristic of this species.

---

[1] *Schlosser*, l. c. p. 126.

The height of the molars is greater in *D. punjabicus* than in the other species. On the other hand, the individual cusps appear to be slightly lower than in *D. rhenanus*, although a comparison with a cast of m_3 of *Dryopithecus darwini*, which Professor Abel has been kind enough to send me, shows no difference between my species and Professor Abel's.

In conclusion, although this mandible is near enough to each of these other species of *Dryopithecus* to leave no doubt as to its generic position, there are such differences as to render it impossible to place it in any one of them rather than another, and justification seems to be afforded for specific distinction.

Maxilla.

Some years later than the discovery of the mandible just described, Sub-Assistant Vinayak Rao found at Haritalyangar, in Belaspur, one of the Simla Hill States, a beautifully preserved right maxilla (Ind. Mus. D. 185), containing the two premolars and the front two molars; this specimen is figured in Plate III. I at first referred it to the genus *Palæopithecus*, as a species more primitive than the species *P. sivalensis*. This, however, was before I had been struck by the remarkable analogy in structure and ornamentation between these molars and those of the Chinji mandible. In addition to the four teeth mentioned, the fragment shows the adjoining portions of the alveoli of the canine and of m^3 as well as the base of the jugal process. The edge of the maxilla above the canine is intact. The following are the dimensions in millimetres of the four teeth :—

——	M^2.	M^1.	Pm^4	Pm_3.
Length	10·6	10·4	6·6	7·0
Breadth	11·4	11·3	9·7	9·5
Height	5·6	5·3	5·5	6·2
Breadth Index	107·5	108·6	146·9	135·7

Penultimate upper molar.—This tooth is constructed on the usual plan of anthropoid upper molars and consists of four main cusps. Of these, the paracone is slightly stronger than the metacone and the protocone considerably stronger than the hypocone. All the cusps fall very gently towards the centrum and steeply away from it, the outer walls of the tooth being distinctly steeper than the inner walls. The protocone and the metacone are connected by a strong ridge, running obliquely across the tooth, and the protocone and hypocone by an equally strong one, which forms the inner edge of the tooth. The protocone and paracone are also connected by a continuous ridge, parallel to and not far from the front edge of the tooth. Besides this, an oblique crest runs from the outer corner of the paracone towards the front edge, where it meets another similar but slightly weaker one proceeding from the protocone. Between this and the last mentioned ridge is a deep furrow, which is continued, though weakened, over the paracone and a small way down the external wall of the tooth. Six smaller folds run down from near the summit of the paracone towards the main valleys which separate that cusp from the protocone and metacone. The corresponding furrows run a short way down the outer wall of the tooth and produce in side view a serrated edge, which reminds one of the similar appearance on the internal edge of the lower molars. Three corresponding ridges, but less distinct owing to the greater wear on that side, run from the protocone towards the centrum, anterior to the connecting crest between the protocone and metacone. The metacone has three folds which produce crenations on the outer edge. The folds on either side of the crest uniting the protocone and metacone are almost entirely obscured by wear. A strong ridge runs backwards from the metacone to the hinder edge of the tooth and meets a corresponding and equally strong one from the hypocone. One or two obscure folds descend on the front side of the latter ridge into an exceedingly deep cavity, from which a deep furrow proceeds between the hypocone and the connecting crest between metacone and protocone. On its way towards the inner edge of the tooth this furrow dichotomizes. The front branch runs up towards the protocone and does not reach the edge, but the hinder branch runs down to the base of the crown. The main furrow between the paracone and the metacone also runs down the external wall to the base of the crown. Between these various folds the enamel surface is absolutely smooth and polished.

A faint trace of a cingular connection between the protocone and hypocone can just be made out.

This tooth has three roots.

First upper molar.—This tooth wants the postero-external corner of the metacone. It is slightly inferior in length and breadth to m^2, but is broader in proportion to its length. Almost exactly the same sculpture can be distinguished on the surface of this tooth as on the last, only it is not always so plain on account of its more advanced wear. The only important differences are the somewhat stronger hypocone and the presence of a very strong ridge, in addition to those mentioned for m^2, which connects the hypocone with the metacone, running right across the hinder cavity of the tooth. A faint trace of a cingular connection between the paracone and the metacone can also be just made out. M^1 is three-rooted.

Hinder upper premolar.—This tooth is much broader than long, and consists of an inner and an outer cusp, both of which fall equally steeply towards the sides and the middle of the tooth. The outer cusp is higher than the inner one. Both have strong ridges, running forward and backward from the summit, though they are stronger in the case of the outer than of the inner cusp. Two strong ridges run from each, parallel to the hinder wall of the tooth, to meet in the mid line. The foremost of these two ridges is continuous right across the middle of the tooth, but the hinder one is cleft by a median furrow. Two additional transverse ridges run from the ends of the anteroposterior ridges mentioned above and form the front and back edges of the tooth respectively. Three deep cavities, one median and the others anterior and posterior are formed between these ridges. These two latter stand at a lower level, that is nearer the base, than the median cavity. The posterior one of these is continued by a furrow, which passes over the outer edge of the tooth and can be seen on the external wall. An additional short fold runs down from the summit of the outer cusp into the hinder cavity. This tooth is three-rooted, the roots being divergent.

Front upper premolar.—The front wall of this tooth is not parallel to the hinder wall, owing to the forward prolongation of the antero-external angle, which makes the external side of the tooth longer than the internal side. The internal side is actually shorter than the corresponding side in pm^4, while the external side is longer than in pm^4. In other respects, the structure of the two premolars is very similar. There are the same four cross ridges, of which the hinder of the two central ones is cleft by a median furrow. The foremost cavity sinks, however, to a lower level than in pm^4, while the foremost of the ridges is continued as a strong crest on the external wall of the tooth, with a corresponding furrow in connection, which runs down to the base of the crown. Additional short ridges run from the summits of both cusps into the central cavity. This tooth has also three divergent roots.

The dimensions of these teeth, the moderately low cusps, the complexity of the folding of the enamel, and, above all, the peculiar serrated outer edge of the molars incline one so strongly to the opinion that we have before us a maxilla and mandible which belong to the same species, that, unless fairly conclusive evidence were forthcoming of a close affinity to another genus, or of the existence of features in the maxilla, which told against an affinity with *Dryopithecus*, I should feel fairly certain that the similarity mentioned between the mandible and the maxilla indicated specific identity.

The only upper teeth of *Dryopithecus* known are the two molars from the Suabian Bohnerz of Melchingen, figured both by Branco[1] and Schlosser[2] and described in detail by the latter. One of these is almost unworn and shows the foldings perfectly; the other is badly worn. Certain details of the enamel sculpture are not as plainly shown on the Haritalyangar specimen as on the Bohnerz tooth, owing to the more advanced wear of the former, but, apart from minute differences, the two agree so closely as to make it fairly certain that they belong to the same genus.

I know of no other upper molars, which approach these at all nearly in structure. Those of Man and the Chimpanzee are distinguished by their much less complicated system of folds, especially in the hinder part of the tooth. Man and the Orang have distinctly broader molars, the excess of breadth over length being particularly marked in m^2. The upper, like the lower molars of the Orang, are clearly distinguished from these by the profuseness of the wrinkles, with which the whole surface of the crown is covered. Gorilla approaches these teeth somewhat in the complication of the folds, but can easily be distinguished by the elevated cusps and the deep furrows which separate them from one another. The molars of the Gibbon exhibit not only the same deficiency of the main folds, which has been noticed in the case of Man and the Chimpanzee, but the secondary folding is almost entirely absent. The latter character prohibits any near affinity with *Pliopithecus*. *Neopithecus*[1] is known only by the last lower molar, but the smaller breadth index of this is indicative of narrower upper molars than is the case in *Dryopithecus*. Its folds are also feebler. *Griphopithecus*[2] is clearly distinguished from the present specimen and from the upper molars of *Dryopithecus rhenanus*, by its exceedingly large breadth index, by its very much simpler structure and by the absence of the finer system of folding. *Pithecanthropus* has molars at least as broad as *Griphopithecus*. *Palæopithecus* has a very massive hypocone, which, however, is so closely approximated to the protocone and to the ridge connecting the protocone with the metacone, as to leave no room for the complicated system of ridges and folds which *Dryopithecus* shows in this position. In consequence of this, also, the breadth index of the *Palæopithecus* molar is considerably in excess of what it is in *Dryopithecus*. The badly worn condition of the maxilla of *Palæopithecus* occasions a doubt as to the details and intensity of the sculpture, but it is likely that in the unworn tooth the cusps were higher, the folding less, but coarser, and the enamel thicker than in the Haritalyangar species. The differences in the premolars of *Palæopithecus* will be commented upon later. *Sivapithecus* alone remains; this is known only by lower teeth, which are also little worn. Judging, however, by the massiveness of the cusps, the greater coarseness of the folds, the high breadth index and other mandibular features, which indicate a nearer affinity to Man than other apes exhibit, it is unlikely that the Haritalyangar maxilla belongs to the same genus as the *Sivapithecus* mandible.

---

[1] Branco, Die menschenahnlichen Zahne aus dem Bohnerz der schwabischen Alb. *Jahresheft. d. Vereins f. vater. Natur. Wurttemburg*, LIV (1898), pp. 1-144.

[2] Schlosser, l. c., p. 125.

Having reached the conclusion that this maxilla belongs to the genus *Dryopithecus*, the differences from *Dryopithecus rhenanus*, the only species of *Dryopithecus*, in which the upper molars are known, may be summed up as follows. The breadth index of the molars is greater. The cusps are probably lower. The outer cingulum is less clear. In the Haritalyangar maxilla the furrows on the outer cusps cross the edge of the tooth, and so produce in side view a serrated appearance, which appears to be absent from *Dryopithecus rhenanus*.

---

[1] *Neopithecus-Anthropodus brancoi*, Schlosser, l. c., p. 119. Abel, l. c., p. 1173.
[2] Abel, l. c., p. 1177.

We may now proceed to discuss the affinities of the premolars—the first upper premolars of the genus *Dryopithecus*, which have so far come to light. The most characteristic feature of these teeth is the existence of the two well marked central ridges which connect the inner and outer cusps. This character is quite in accord with the intensity and number of the folds which the molars of *Dryopithecus* exhibit. In Man and the Gibbon, there is no trace of them, the single central cavity being bounded solely by the anterior and posterior ridges, which form the front and back edges of the tooth. *Palæopithecus* seems to show a trace of the same structure, so far as it is possible to make out the details on a crown that is nearly worn down. In *Palæopithecus*, the anterior and posterior ridges are on a distinctly lower level than the middle of the tooth, as is the case in *Dryopithecus*, while in the raised convex median portion there is a faint furrow. I am not, however, inclined to think that either the central ridges or the median cavity were ever so pronounced, as is the case in the Haritalyangar maxilla. There seems to be an approach to the same conformation in pm^4 of the Chimpanzee, though I have not had the opportunity of examining an actual unworn specimen. In the Gorilla we have essentially the same structure, with the important difference that the two folds do not meet in the mid line of the tooth, so that the central cavity are less well defined. A trace of an analogous condition is, however, visible in the hinder ridge of the Haritalyangar premolars, which is bisected by a median furrow. As a whole, in the Gorilla the folds are not thrown into such strong relief as is the case in *Dryopithecus*, due to the successive alternation of continuous ridges and deep hollows. In the Orang the arrangement of the main folds of the premolars is the same as in the present species, but the ridges and the central cavity are less clearly defined, on account of the complicated system of secondary folds and wrinkles, which are absent in the fossil tooth. The breadth of both the premolars is very much behind what obtains in *Palæopithecus* and the Chimpanzee, though this measurement seems to be somewhat variable in the latter ; it is in excess of that of the other living apes and Man.

The breadth index of pm^3 in *Dryopithecus* is less than would be the case, were not the length increased by the prolongation of the antero-external corner. No anthropoid species has hitherto been discovered, which has its pm^3 extended to such a marked degree at the antero-external angle, so as to be almost triangular in shape.

Such a pm^3 occurs in some of the *Cercopithecidæ*, and an undoubted trace of a similar conformation exists in the Gorilla, and the Orang with even the small ridge on the outer cusp, to which attention has already been called. Pm^3 of *Palæopithecus*, though it has lost the major portion of its crown, is shown by what remains to have had quite a different shape.

The three divergent roots of both the premolars are similar to those of the Orang, Gorilla, and Gibbon. The Chimpanzee has a three rooted pm^3, but its pm^4 has three roots only very occasionally. In Man both premolars have two parallel roots. The premolars of *Palæopithecus* have three roots, but they are more parallel than in *Dryopithecus*.

Isolated upper molars.

The last two specimens, which I have to consider under the head of *Dryopithecus punjabicus*, are Ind. Mus. Nos. D. 186 and D. 187, which were found in the Chinji zone of the Lower Siwaliks near Chinji, without any more exact record of their locality being preserved. No. D. 186 is a 3rd left upper molar and No. D. 187 one of the two left front molars.

Front upper molar.—The dimensions of this tooth are: length 10·0 mm., breadth 10·9, height 5·7, breadth index 109·0. It is figured in Pl. II, fig. 4. Though less worn by attrition during the animal's life than the Haritalyangar molars, it is not so well preserved, but in all essential respects, it resembles them very closely. The cusps are slightly higher, and they slope more steeply towards the centrum, and less steeply on the inner side of the tooth, so that they are rather more pyramidal in shape than in the maxilla. The two ridges, which proceed from the paracone towards the protocone and parallel to the front edge of the tooth, end in a small but distinct cusp, adjacent to and in advance of the protocone. This small cusp recalls that described by Schlosser[1] in an upper molar of *Dryopithecus rhenanus*. No doubt if the Haritalyangar maxilla were less worn a similar cusp would be visible. Even as it is, in certain lights there is a faint trace in the latter specimen of a furrow in this position. The furrows on either side of the connecting crest between the metacone and the protocone are rather deeper than in the Haritalyangar teeth, and the main furrow between the protocone and the hypocone is rather more intense. I do not, however, regard the differences as sufficient to prohibit the inclusion of it in the species *Dryopithecus punjabicus*. As its dimensions accord more with those of m^1 in the Haritalyangar maxilla it is probably to be referred to that position in the jaw.

---

[1] Schlosser, l. c., p. 125.

The occurrence of an upper molar in the Chinji area similar to the molars in the maxilla from the Simla region is interesting as affording further testimony in favour of referring the maxilla in question to the same species as the type mandible.

Last upper molar.—The tooth, just described, is also important, for the reason that the features, which I have mentioned above as different from those of the molars in the maxilla, are shared by the isolated m^3 (D. 186), which does not carry on it the hall-mark of identity with the maxilla. Hence any feature, which this m^3 shares in common with D. 187, may be regarded as an argument in favour of assigning the former to the species *Dryopithecus punjabicus*. Still the reference must be regarded as quite provisional.

The tooth, which is represented in Pl. II, fig. 5, is not much worn, but the conditions of fossilization have not been such as to preserve the details of the specimen so well as the maxilla. The cusps are higher than those of the co-type, and more pyramidal in shape, because they slope more abruptly to the centrum and less abruptly towards the base of the crown. Its dimensions are: length 9·6 mm., breadth 11·3, height 5·8, breadth index 117·7. Its antero-posterior, therefore, greatly exceeds its transverse diameter. The latter is greatest at the front of the tooth, and diminishes rapidly backward.

The usual four main cusps of the anthropoid upper molar can be easily distinguished. Of these, the protocone is the largest, the paracone falling slightly behind it in point of size. Both the metacone and hypocone are much reduced. The paracone has a ridge running backward and forward from the summit, and two well marked ones in the direction of the protocone, of which the front one forms the anterior edge of the tooth. Between these two ridges is a deep furrow, similar in character to that in the molars of the Haritalyangar maxilla. Both of these ridges end in a secondary cusp, adjoining and in advance of the protocone. This is more distinct, but similar in character to the one, just referred to in the isolated m^1 in precisely the same position, and recalls the similarly situated cusp described by Schlosser in the upper molar of *Dryopithecus rhenanus*. In the present tooth a furrow runs down the wall of the crown, at the antero-internal corner, between this secondary cusp and the protocone.

The other folds on the paracone and protocone are very obscure. The ridge connecting the metacone with the protocone is cleft by two furrows, both of which are more deeply cut on the side which enters the main valley between the protocone and paracone, thus producing another secondary cusp in the very middle of the tooth. The hypocone is connected with the metacone by a single ridge, forming the posterior edge of the tooth, as in m^2 of the Haritalyangar maxilla, and different from m^1 of the same maxilla, where there is a double ridge. In the present tooth this ridge is cleft by two furrows, which unite into one towards the centrum, to form the valley between the hypocone and the connecting protocone-metacone ridge. These two furrows just cross the edge of the crown, thus producing a third secondary cusp, adjoining the hypocone and behind the metacone. The hypocone contains some additional obscure folds, which end in the main valley between it and the protocone-metacone connecting ridge. This latter valley dichotomizes into two furrows, in precisely the same manner as has been described in the case of the molars of the Haritalyangar maxilla. The foremost of these branches runs up towards the protocone and again dichotomizes, the one of these secondary branches running into the furrow mentioned above, by which the protocone-metacone ridge is cleft, the other running to the inner edge of the tooth which it just crosses. The hindermost of the two branches of the main posterior valley runs vertically down to the base of the crown as a deep furrow, separating the protocone and the hypocone. On either side of this furrow, a cingular connection between the protocone and the hypocone is very distinct, far more so than the similar feature in m^2 of the Haritalyangar maxilla.

Comparing this tooth with the corresponding one of other genera, it differs from Man and *Pithecanthropus* by the much smaller reduction. In both the Chimpanzee and Gorilla, although the reduction of the hinder portion of m^3 seems, as a rule, to be no less than in this tooth, yet that reduction has not affected the metacone much, which is very much larger than it is in the Chinji tooth. This is equally applicable to the m^3 of *Palæopithecus*. M^3 of the Orang approaches this somewhat more nearly in structure, but the complex system of wrinkles in that genus prohibits any very near affinity. From the Gibbon as from *Griphopithecus* it is distinguished by the absence of folding in those genera. The corresponding tooth from Chinji, which has been assigned to the new genus *Palæosimia,* differs from this, both by its exceedingly strong series of wrinkles, and by its inferior breadth index.

In conclusion the intensity and disposition of the folds of this tooth do not agree with any other genus so well as with *Dryopithecus*; moreover, the dimensions, as well as many details of structure, accord with those of the Haritalyangar maxilla and with the Chinji upper molar. I have, therefore, no hesitation in assigning it provisionally to the species *Dryopithecus punjabicus.*

DRYOPITHECUS CHINJIENSIS n. sp.

PLATE II. FIGS. 6, 7.

The type of this species is a last left lower molar, Ind. Mus. D. 179, figured in Pl. II, fig. 6, which was found in the Chinji horizon of the Lower Siwaliks, in the neighbourhood of Chinji, by Sub-Assistant M. Vinayak Rao.

It is with some doubt that I assign this tooth to the genus *Dryopithecus,* since its cusps are rather higher than one would expect, but as its other characters do not seem to ally it to any other genus and are closer to those of *Dryopithecus,* I propose to provisionally place it here.

Its dimensions are as follows: length 14·7 mm., breadth 12·7, height 7·8, breadth index 86·4. The greatest breadth lies in the anterior portion of the tooth, but it hardly begins to diminish appreciably until the hinder third, differing in this respect from *D. punjabicus.* The hypoconid, thus, does not lie internally to the protoconid, but on the other hand the mesoconid is more displaced from the line of the other two external cusps than is the case in the last species: in this respect it recalls *D. rhenanus.* The folding of the enamel is fairly distinct on the internal cusps, but has been largely affected by wear on the external ones. The metaconid is the largest of the cusps, but the other four cusps are approximately equal in size; thus, the entoconid and the hypoconid are larger than in *D. punjabicus,* again showing a greater resemblance to *D. rhenanus.* The cusps slope gently towards the centrum, but more abruptly towards the sides of the tooth, much more abruptly on the internal than on the external side. There is a distinct cingular connection between the protoconid and the hypoconid, situated about half way down the base of the crown, though not quite so broad as in *D. punjabicus*, and the faintest trace of one between the hypoconid and the mesoconid. There is a small secondary cusp between the entoconid and the mesoconid, but it is not possible to say that there is one between the metaconid and the entoconid, although a short furrow on the metaconid indicates a region, which corresponds to the secondary cusp in *D. punjabicus.*

Two parallel ridges connect the protoconid and the metaconid, one along the front edge of the tooth and the other immediately behind it. The cavity between these two ridges is a slight one. Behind this again there are three other folds on the metaconid ; the furrow, associated with the middle one of these, just passes over the edge of the crown and produces a serration in side view. Traces of four folds are visible on the entoconid. The furrow, which separates the hinder secondary cusp from the entoconid, is only faintly visible in side view.

The breadth index of this tooth agrees very well with that of *Dryopithecus*, being a little higher than *D. rhenanus* and *punjabicus*, though not so high as in *D. darwini.*

The only other genus with which it might be compared is *Sivapithecus*, with which it agrees in the height of its cusps. The much higher breadth index of m_3 in that genus is sufficient to distinguish it, together with its greater simplicity both as regards folding and general structure of the tooth, the smaller size of the metaconid, and the more backward position of the mesoconid.

It can be distinguished from *Dryopithecus fontani*, in which the cusps are higher than the other species of *Dryopithecus*, by the more inward position of the mesoconid and the smaller cingulum. From this, as well as from every other species of *Dryopithecus* hitherto known, it differs by its greater absolute dimensions.

I have in my collection from the Lower Siwaliks of Chinji two lower molars, (Ind. Mus. Nos. D. 180 and D. 181), of which the former is figured in Plate II, fig. 7, which seem to belong here. They are, obviously, front molars, both on account of their shape and on account of the presence of facets of wear on the hinder as well as the anterior wall of the tooth.

Their dimensions are as follows :—

	D. 180.	D. 181.
Length	11·4	11·7
Breadth	10·0	10·2
Height	6·7	5·2
Breadth index	87·3	87·1

The cusps of the former of these teeth are too high to permit us to assign it to the species *D. punjabicus.* Moreover, its simpler structure, the absence of a cingular shelf between the outer cusps and its higher breadth index militate against the possibility of its being m_2 of that species. Its greater absolute size, apart from the other differences mentioned above, would prevent us from considering it as m_1 of *Dryopithecus punjabicus.*

From its general character and breadth index it might well be the left m_1 of *Dryopithecus chinjiensis.* It is a little smaller than one would perhaps have expected, but the dimensions of m_1 of *Sivapithecus* bear almost the same ratio to those of m_3 as is the case here.

The second tooth is on the right side and is in an extremely advanced stage of wear and beyond the fact that it agrees perfectly in general structure with the last specimen, nothing more can be said about it. It seems to have belonged to a larger individual than the owner of D. 180.

DRYOPITHECUS GIGANTEUS n. sp.

PLATE II. FIG. 8.

The isolated tooth (Ind. Mus. D. 175), figured in Pl. II, fig. 8, was obtained from a bed of cream-coloured, concretionary sandstone on the northern edge of a hill, which is situated close to and north of the small village of Alipur in the eastern part of the Salt Range area on the south-eastern flanks of Diljabba ridge, on the meridian 73° 14′ and is therefore 3 miles north of the map, which accompanied the author's paper on the Correlation of the Siwaliks with Mammal horizons of Europe[1].

It is very near the boundary between the Lower and Middle Siwaliks, but as the typical red concretionary beds of the Chinji zone are well exposed below the bed in which the tooth was found, and as this bed does not differ materially from certain beds of the Middle Siwaliks at Nagri, 10 miles east of Chinji, I have little hesitation in assigning it to the Nagri horizon of the Middle Siwaliks[2].

The specimen is merely the crown of a tooth, without any roots attached thereto. Its dimensions are as follows: length 19·1 mm, breadth 15·3, height 8·5, breadth index 80·1. It is, thus, much longer than broad and contains the five typical cusps of the anthropoid lower molar. It does not taper at all within the limits of the two external or the two internal cusps and only very slightly on the external side at the level of the mesoconid. It is thus almost a rectangular tooth. The cusps descend steeply to the base of the crown on the internal side and more gently on the external side. From both sides the descent to the centrum is gradual.

---

[1] Pilgrim l. c. Pl. 27.

[2] Pilgrim l. c. p. 267, 318.

Of the main cusps the metaconid is the largest and highest, the protoconid and hypoconid are about equal in size and height, the entoconid is a little smaller, and the mesoconid is the smallest of all. The general height of the cusps is slightly in excess of what is probably the case in *Dryopithecus punjabicus*, but in defect of *D. chinjiensis*. There is no trace of a cingulum or of a cingular connection between the outer cusps, the furrows between them as between the other main cusps being deep and running right down to the base of the crown.

In its general structure and the nature of the enamel foldings, this tooth can be easily seen to correspond fairly exactly with the species *Dryopithecus punjabicus* and, as far as I can judge, with the other previously described species of that genus. The secondary cusps, which Schlosser has described for *D. rhenanus* and Abel for *D. darwini*, exist in this tooth as what may be described as a series of small cusps or in the case of the hinder, between the mesoconid and the entoconid, as a crenulated ridge. The appearance of this tooth in side view is, in fact, almost identical with the corresponding one in *D. punjabicus*, except that here four crenulations are visible instead of three. This tooth is, no doubt, less affected by wear than those of *D. punjabicus*, and its greater absolute size also tends to make the wrinklings appear stronger than they otherwise would; still there seems no doubt that the folds and furrows, though occupying precisely similar positions to what they do in *D. punjabicus*, are both more numerous and more intense than in the latter species.

The specimen must be the last right lower molar, both because of its shape and the absence of any posterior facet of wear.

It is very considerably larger than any hitherto described species of *Dryopithecus*, but it does not seem possible on that account to separate it from them generically.

Its low breadth index separates it from every other genus except *Neopithecus* and *Pliopithecus*. The m_3 of the former is still more elongated than in my specimen and differs besides by the much weaker cusps and folds. The latter genus differs by the entire absence of wrinkling and by the strong cingulum.

M_3 in the Gorilla, besides being broader, has much higher, more isolated cusps, much fewer wrinkles and generally a more simple structure.

By its size alone it can be distinguished from all other species of *Dryopithecus*. It seems to agree more nearly with *D. fontani*, by its rectangular shape, its higher cusps and its crenulated internal edge. The mesoconid in m_3 of that species is, however, more in a line with the protoconid and the hypoconid than in *D. giganteus*, and there is a distinct cingulum in the main type of *D. fontani*.

From *D. darwini* my species differs by its absence of backward taper, and of a cingulum as also by its more elongated shape, the greater frequency of its main foldings and the greater inward displacement of the mesoconid.

The breadth index would seem to approach more nearly that which obtains in *D. rhenanus*, but in that species m_3 tapers more and the mesoconid is more inwardly displaced, while the folds appear to be less numerous than in *D. giganteus*. The sub-triangular shape of *D. punjabicus*, its greater breadth index, its lower cusps and the cingular shelves are the most noteworthy points of difference from *D. giganteus*.

D. chinjiensis differs by its greater breadth index, its higher cusps and its altogether simpler structure.

PALÆOSIMIA RUGOSIDENS n. gen. n. sp.

PLATE II. FIG. 9.

This genus and species is founded upon a last right upper molar (Ind. Mus. D. 188), figured in Plate II, fig. 9, which was obtained from the Chinji zone of the Lower Siwaliks in the neighbourhood of Chinji, though its exact locality is unknown.

Its dimensions are as follows, length 10·8 mm, breadth 11·9, height 6·3, breadth index 110·1. The tooth is broadest in its front portion and diminishes fairly rapidly backward, both inner and outer sides converging at approximately equal angles. The four main cusps of the anthropoid upper molar can be easily distinguished, the largest being the protocone, the paracone falling considerably behind it in point of size ; the metacone is somewhat smaller than the paracone, while the hypocone is much reduced. The crown is but little worn and the sculpture of the surface is perfectly preserved.

It will be most convenient to compare this tooth with the isolated last upper molar (Ind. Mus. No. D. 186), which has been described under the head of *Dryopithecus punjabicus* (p. 23), and I may at once say that the question of referring these two teeth to the same genus has been strongly in my mind, and has caused me a considerable amount of hesitation.

The two anterior transverse ridges, connecting the protocone and the paracone, are present and end in a distinct cusp in advance of the protocone. The front one of these ridges is slightly crenulated. The paracone has five strong folds in addition, and each of these has numerous crenulations across it. The protocone has an additional four, the metacone seven, the hypocone two and all of these have the same cross crenulations. The connecting ridge between the metacone and the protocone is cleft by deep furrows, which separate its median portion as a distinct central cusp even more markedly than in the m^3 of *Dryopithecus punjabicus* referred to above. This also possesses folds both in front and behind. There are two crenulated secondary cusps behind, between the hypocone and the metacone. All the cusps are low, but, in spite of the numerous secondary folds, the main boundaries between them can be distinguished better than in the Orang. The furrow between the protocone and the hypocone only just crosses the edge of the tooth, and is no more pronounced than those between the two hinder secondary cusps or the furrow separating them from the hypocone.

Thus it will be seen that the characteristic feature of the present tooth is the number and intensity of the wrinkles on the enamel surface. In this respect it can only be compared with the Orang among recent or fossil anthropoid genera. It seems to me quite impossible that the m^3 (No. D. 186), referred to above, could have possessed so strong or so numerous wrinkles. The general structure of the two teeth is rather similar, but the same might be said of the Orang, which in regard to the character and arrangement of its folds is nearer to *Dryopithecus* than to any of the living genera. Certain other differences, moreover, seem to support the view that the two teeth belong to generically different animals, and that the present genus was derived from a hypothetical marginal species of

Dryopithecus, perhaps somewhat nearer to *D. darwini* than to the later species, and in any case with characters approximating more nearly to those of the Orang.

These differences are as follows:—

(1) The breadth index of this tooth is very much greater than that of No. D. 186.

(2) The protocone is much larger proportionately, while the metacone is not so reduced.

(3) Corresponding to the reduction of the metacone in *D. punjabicus*, the outer edge of the tooth runs inward much more obliquely than is the case in the present specimen.

(4) The cingular connection between the protocone and the hypocone in *D. punjabicus* is wanting in the present specimen.

(5) The inner edge of this tooth forms a sharp rounded curve extending from front to back, much as in the Orang. This edge of the m^3 of *Dryopithecus punjabicus* is practically straight.

PALÆOPITHECUS SIVALENSIS, Lydekker

1879. *Palæopithecus sivalensis* Lydekker, Further notices of Siwalik Mammalia, *Rec. Geol. Surv. Ind.*, XII, p. 33.

1886. *Troglodytes sivalensis* Lydekker, Indian Tertiary and Post-Tertiary Vertebrata *Pal. Ind.*, ser. X, vol. IV, pt. 1, p. 2.

1897. *Palæopithecus sivalensis* Dubois, Ueber drei ausgestorbene Menschenaffen, *Neues Jahrb. f. Min. Geol. u. Pal.* Stuttgart, vol. I, p. 84.

The maxilla, on which the present species was founded, has been described both by Lydekker and Dubois. The latter writer questioned Lydekker's later attribution of the species to the same genus as the Chimpanzee and resuscitated his earlier generic name. I have carefully examined the specimen and remeasured it, with the result that I entirely agree with Dubois as to its claim to generic distinctness. I may add that my measurements of the individual teeth have been made for each tooth separately without regard to its relation to the other teeth in the series; they are taken in the direction which anyone would naturally adopt, supposing they were isolated teeth. In this way they should be more accurately comparable with the numerous anthropoid teeth which are found detached from their mandible or maxilla. The measurements are tabulated, for comparison with other genera, on page 68. I may also remark that all the teeth are so much worn that it seems unfair to base any conclusions either on the apparent lowness of the cusps or the absence of crenulation on the enamel. I should, on the contrary, conclude from the few traces of sculpture still left on the left m^2 and by the general appearance of the teeth that in both of these respects they do not differ at all from *Sivapithecus* and early types of Man. The cusps are, therefore, higher than in most species of *Dryopithecus*, while the folding is probably coarser than it is in that genus, though not so complicated.

The differences of *Palæopithecus* from the Chimpanzee may be summarized as follows:—

(1) The palate is narrower than in the Chimpanzee.

(2) The molars and premolars are broader in proportion to their length; this breadth is especially noticeable in the front portion of the series.

(3) In spite of the breadth of m^3, the degeneracy, as estimated by the disappearance or reduction of the hypocone, is less than in the recent genus.

(4) In *Palæopithecus* both pm^4 and pm^3 are 3-rooted. In the Chimpanzee pm^4 is never 3-rooted and pm^3 only occasionally so.

(5) The height of the cusps is probably greater than in the Chimpanzee.

(6) The crenulation of the enamel is probably much less than in the Chimpanzee, although it is coarser.

(7) The incisors are smaller than in the Chimpanzee.

(8) In pm^4 of *Palæopithecus* the ridges are probably more continuous across the crown of the tooth than in the Chimpanzee.

(9) The canine is larger in *Palæopithecus*.

(10) In *Palæopithecus* the line of the teeth is not convex outwardly as in the Chimpanzee.

(11) The two premolars lie inside the line of the other teeth, and the configuration of the maxilla above them is more like that in Man than the Chimpanzee.

From Man *Palæopithecus* differs in many respects of which some of the most important are the following:—

(1) The narrow palate.

(2) The greatly inferior breadth index of m^2 and m^3 due to the degeneracy of these teeth in Man.

(3) The greater reduction in length of the front portion of the molar-premolar series in *Palæopithecus*.

(4) In Man both the premolars are 2-rooted teeth.

(5) The premolars, though broad, are more complicated in *Palæopithecus* than they are in Man.

(6) The much greater size of the canine in *Palæopithecus.*

(7) The more forward position of the incisors in *Palæopithecus* and consequently the much slighter concavity of the front portion of the palate.

Palæopithecus is more nearly allied to *Dryopithecus* than to either Man or the Chimpanzee. Its narrow palate and its small incisors resemble very closely these parts in *Dryopithecus.* Differences from *Dryopithecus* may however be seen in the following particulars :—

(1) The greater breadth index of the molars and premolars, more particularly marked in the front molar and the two premolars.

(2) Probably the cusps in *Palæopithecus* are higher and the folding of the enamel less complicated, though coarser, than in most species of *Dryopithecus.*

(3) If the m^3 (Ind. Mus. No. D. 186) is correctly referred to *Dryopithecus* then *Palæopithecus* differs by the greater breadth of the posterior portion of that tooth and by the larger metacone. This tooth is in fact more degenerate in *Dryopithecus.*

Palæopithecus differs from both the Orang and the Gorilla by the large breadth index of the front molar and the two premolars, while the former of these genera can be distinguished by the number and intensity of its enamel folds, and the latter by its high cusps separated by deep furrows.

Differences from the Gibbon may be found in—

(1) The greater breadth of the teeth.

(2) The more complicated although broader premolars.

(3) The absence of wrinkling from the teeth of the Gibbon.

(4) The cusps in *Palæopithecus* are probably higher than in the Gibbon.

(5) The palate in *Palæopithecus* is much narrower.

(6) M^3 in the Gibbon is more degenerate than the corresponding tooth in *Palæopithecus.*

The differences of *Palæopithecus* from *Sivapithecus* will be detailed under the head of the latter genus.

An undoubted resemblance may be traced between *Palæopithecus* and *Pliopithecus*. This has been noticed by Dubois[1] and is due to the shortness of the premolars and the front molar in both genera, in addition to the narrow palate and the small incisors.

They differ by the absence of wrinkling in the enamel in *Pliopithecus*, and by its strong cingulum, a very distinct trace of which can, however, be detected in *Palæopithecus*.

By the great breadth index of m^3, *Griphopithecus* recalls *Palæopithecus*. That genus, however, may be distinguished by the simpler structure and absence of wrinkling, without, however, any reduction in the number or size of the cusps.

HOMINIDAE

SIVAPITHECUS INDICUS, Pilgrim

PLATE I, FIGS. 7-9. PLATE II, FIGS. 1-3.

1910. *Sivapithecus indicus*, Pilgrim, Notices of new Mammalian genera and species from the Tertiaries of India, *Rec. Geol. Surv. Ind.*, XL, p. 63.

This genus and species were established on a last right lower molar (Ind. Mus. D. 176), wrongly stated to have been found at Alipur, and really picked up by a villager in the Chinji zone of the Lower Siwaliks in the neighbourhood of Chinji. As this tooth was rather misleadingly and in any case very insufficiently described, I am taking as the type of the genus and species a right mandibular ramus (Ind. Mus. D. 177) from the same locality, containing m_1 and m_2; pm_4, and the broken crowns of m_3 and pm_3 with a part of the alveolus of the canine.

Type mandible.

There is no doubt that the isolated last lower molar belongs to the same species as this mandible, but in case of any question arising in the future as to the characters of the genus it is to the mandible (Ind. Mus. D. 177) that reference should be made. The matrix attached to the specimen is a reddish sandstone similar to much that occurs in the Chinji zone, where the specimen was obtained by Sub-Assistant Vinayak Rao. The base of the ramus is everywhere broken, and the actual symphysis is not shown any more than the incisors. The depth of the fragment below the crown of m_3 is 26·4 mm. and below that of pm_3 29·3. The thickness of the ramus is much greater than 19 mm. but is unknown on account of the absence of much of the postero-external portion. At pm_4 it is about 15 mm. It is probable that the broken margin of the mental foramen is visible at the broken edge of the fragment immediately below the level of the posterior part of pm_3, but in any case this foramen is not situated higher than this point, so that the depth of the ramus in front is considerable, and was, probably, in excess of that of the hinder portion, judging by the apparent narrowing of the sides of the ramus in the neighbourhood of the broken lower margin. If this is true, then the shape of the mandible in this particular resembled that of *Dryopithecus* and Man. The actual loss of the lower margin does not, however, allow us to be certain as to the point.

---

[1] Dubois, l. c., p. 97.

Although most of the important portion at the front of the mandible is missing, still enough is left to show certain most remarkable features, which not only clearly differentiate it from any hitherto known genus but provide us with what seems to be an important link in the descent of Man from the lower Primates. First it may be noticed that the jaw curves strongly outward from about the level of the first molar. The three molars are more or less in a straight line but pm_4 stands markedly outside this line and pm_3 still more strongly so. To a very slight degree this outward curvature of the premolar portion of the jaw is present in the Gorilla, but in no way comparable to that which occurs in the present mandible. Strange to say, this unusual curvature in the one direction is accompanied by a curvature in the other, which is equally unusual among the apes, though present in Man. At least, such a condition must be inferred from the position of the canine, internal to pm_3 instead of directly in advance of it. This internal displacement of the canine is comparable only with what occurs, though to a greater degree, in Man. In the apes the canine is in the same line as the molars and premolars : the ramus only begins to bend round to the inside with the incisor portion so that the bending is far more abrupt than is the case in Man. It seems probable that such a constitution of the front part of the ramus must have involved a more outward position of its hinder part, so that the angle included by the two mandibular rami would be larger and therefore the distance between them greater than in any hitherto known genus of anthropoid ape, the structure in fact approaching what we find in Man.

Possibly, though not necessarily, correlated with this structure is another feature of the mandible of the Chinji genus. This is the shortness of the mandibular symphysis. Although the symphysis cannot be actually seen, yet the portion of the ramus left below pm_3 is sufficiently great to make it certain that if the symphysis had extended back as far as in the Orang, the Gorilla, the Chimpanzee or even the Gibbon it would have been evident in our specimen. The inward curvature of the base of the ramus does not begin until a level midway between pm_4 and pm_3 whereas in the living anthropoid apes it begins opposite to m_1, or even behind it, although the curvature is more gradual in the case of the Gibbon than in the others.

When such a condition coexists with a more inward position of the canine, which implies a backward shifting of the entire incisor portion of the jaw, it is evident that the conformation of the symphysis in the genus *Sivapithecus* must have more nearly resembled that of man than of any other of the genera of anthropoids.

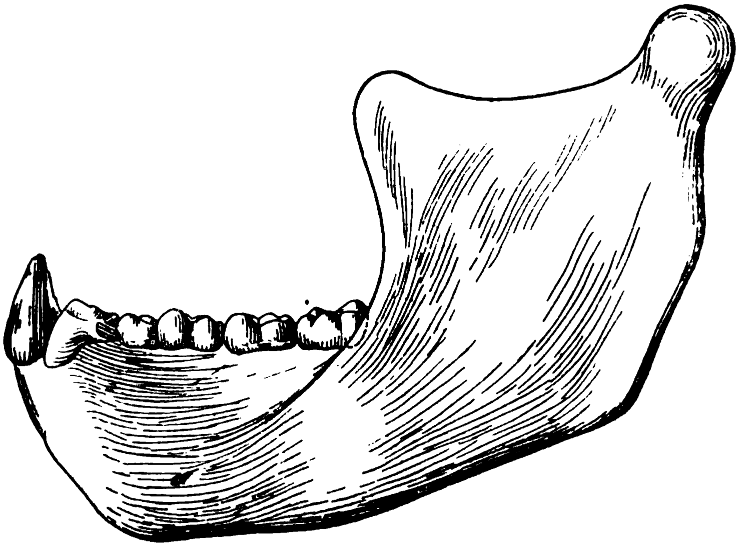


Fig. 1. Ideal restoration of the mandible of Sivapithecus indicus, in left side view; about two-thirds natural size.

An ideal restoration of the mandible of *Sivapithecus* is shown in side and surface view in figs. 1 and 2. It should be clearly understood that this is not intended to represent any specimen, but is merely an attempt to embody the conclusions at which I have arrived after a study of the actual Chinji fragment, considered in the additional light of the two fragments obtained from Haritalyangar, which are described on pages 42 to 46. My conception of the jaw to which the type ramus may have belonged can be conveyed more readily by a pictorial illustration of this kind than by a verbal description. I have, however, no wish to insist on the details of the restoration, which from the fact that the specimens on which it is based do not all belong to the same individual and probably not to the same species, could only by a coincidence be absolutely correct.

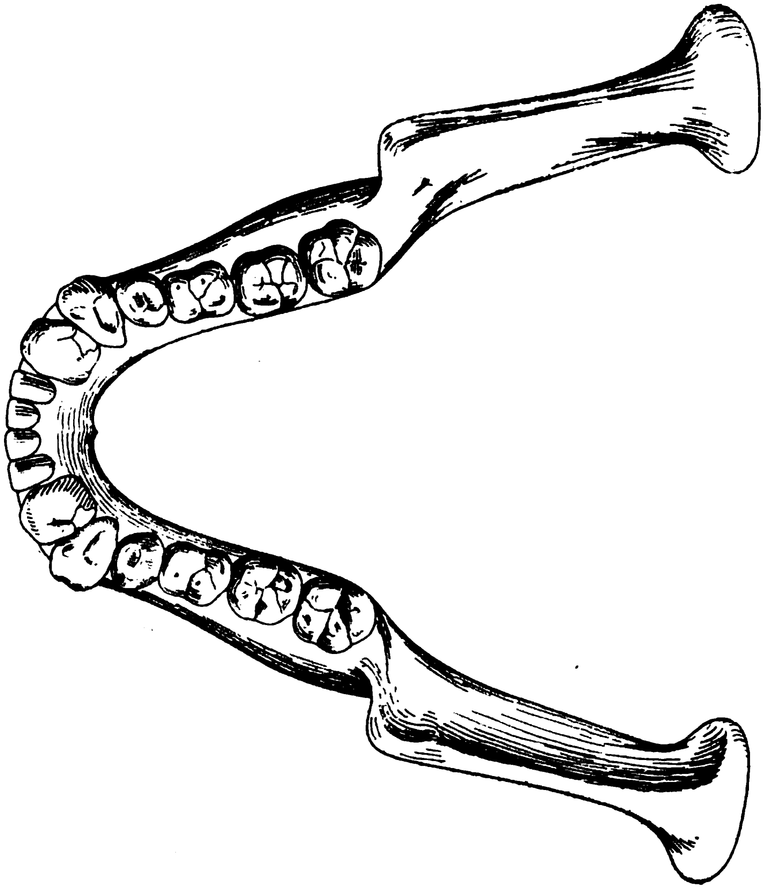


Fig. 2. Ideal restoration of the mandible of Sivapithecus indicus, view from above; about two-thirds natural size

The reconstruction of the angle and ascending ramus of the jaw is imaginary. Their size and general structure are mainly based on those of Heidelberg and Chapelle-aux-Saints; indeed one would expect a considerable extent of surface for the attachment of the powerful masticatory muscles which such an animal must have possessed.

In the case of *Dryopithecus* the symphysis is well known to have extended further back than even in the Orang. The symphysis of *Pliopithecus* is equally well known to have extended as far back as m_1. *Palaeopithecus* from its palatal structure is most unlikely to have had a short symphysis.

The symphysis in *Eoanthropus,* as is clearly shown in Smith Woodward's restoration of the Piltdown mandible[1] must, certainly, have been longer than in the Chinji specimen, as the actual symphysis appears to have extended back to the level of the middle of pm_4 while the inward curvature of the ramus began still further back. The actual length of the symphysis in *Eoanthropus* would seem to have exceeded that of the Gibbon, although the inward bending of the ramus begins further back in the latter genus. This abrupt passage of the ramus into the symphysis and the accompanying absence of any sort of shelf internal to m_1 and pm_4 are features shared alike by *Eoanthropus* and *Sivapithecus* and are, no doubt, to be correlated with the greater breadth in the anterior portion of the jaw. The latter character is evidently a later development as it is certainly not primitive. Schlosser considers that the symphysis in *Propliopithecus* probably only extended back as far as the canine.[2] We may, however, gather that the jaw of *Propliopithecus* was extremely narrow in front, as was the case with the better known *Pliopithecus* from the middle Miocene, and therefore presented an entirely different appearance from that of the mandible of *Sivapithecus.*

We may now pass to the structure of the individual teeth.

Last lower molar.—The dimensions of the isolated tooth (Ind. Mus. D. 176), figured in Pl. I, fig. 7, are: length 14·3 mm., breadth 13·4, height 7·3, breadth index 93·7. The dimensions of the m_3 in the type mandible as calculated from the alveolus are length 14·5, breadth 13·4, breadth index 92·4. These are near enough to amount to evidence in favour of the isolated tooth belonging to the same species as the mandible, especially when both exhibit a breadth which is found in the m_3 of no other anthropoid except Man and the Gibbon. The roots in this tooth are not only long and large, but they show no tendency to diverge; on the contrary their great development seems to have led to a certain tendency towards fusion. The surface, though not much worn by attrition, has been corroded in the course of fossilization, so as to obscure the finer sculpture of its surface. The tooth possesses the usual five cusps, of which the hypoconid is the largest; next to this in size comes the metaconid; the protoconid and entoconid are about equal, and the smallest of the five is the mesoconid. The broadest part of the tooth is opposite the hypoconid, thence it narrows slightly in front and rapidly behind. The mesoconid is very considerably displaced to the inside of the line joining the protoconid and hypoconid, thus presenting an appearance entirely different to that of the Gorilla, Orang, *Dryopithecus*, *Pliopithecus* and *Neopithecus*. In Man and the Gibbon the mesoconid is frequently wanting, and in the Chimpanzee is minute, but where, as in some of the lower races of mankind, a 5th cusp is present, then the general aspect of the tooth most resembles that of Man, except for the larger actual dimensions, the main cusps and the furrows being more pronounced than they are either in the Gibbon or the Chimpanzee. Though the details of the tooth are obscure, it is evident that there was a valley in the front of the tooth, just behind and parallel to the anterior edge, and a small cavity behind, between the mesoconid and the entoconid.

---

[1] Smith Woodward. Description of a Palæolithic human skull and mandible, from Piltdown, Sussex. *Quart. Jour. Geol. Soc. Lond.*, vol. LXIX (1903), pp. 133—138.

[2] Schlosser, Beiträge zur Kenntniss der oligocänen Landsäugethiere aus dem Fayum Agypten *Beitr. z. Pal. u. Geol. Öst-Ung.*, Vol. XXIV (1911), p. 52.

Second lower molar.—This tooth is almost a replica of m_3, except for its inferior length and its greater proportionate breadth. Its dimensions are: length 13·0 mm., breadth 12·3, height 7·2, breadth index 94·6. The breadth of the tooth is no greater at the hypoconid than at the front of the tooth and the hypoconid is rather weaker than in m_3. On the internal half of the tooth the ornamentation is fairly distinct, while on the external half the surface has been corroded just as in m_3.

Two parallel ridges unite the protoconid and the metaconid, as is the case in *Dryopithecus*, but the cavity between them is by no means so pronounced as it is in that genus. An additional fold is seen on the protoconid, behind these, running to the centrum, while on the metaconid are some five short coarse folds: the entoconid has also a few short folds. There are no secondary cusps and no cingulum.

First lower molar.—This tooth has suffered more from attrition than the ones behind it, so that even though the entoconid and the hinder portion of the metaconid have escaped corrosion, the furrows which once existed on them have been worn away. Its dimensions are : length 11·5 mm., breadth 10·6, height 6·2, breadth index 92·1. This tooth is thus both shorter and narrower than m_2 or m_3.

Last lower premolar.—The dimensions of this tooth are : length 8·5 mm., breadth 9·9,[1] height 6·5. It has two divergent roots in which respect it differs from the corresponding tooth of Man, which has only a single root, and that of the Chimpanzee, where the two roots are more or less fused. The outline of the tooth forms roughly a parallelogram with a convex outer side. It consists of an inner and an outer cusp, each with a ridge running backward and forward. The cusps are united by three transverse ridges, of which the foremost and the hindermost form respectively the front and back edges of the tooth. The middle ridge is cleft by a furrow. There is nearly twice the distance between the front ridge and the second one as between the second and the third. The hinder ridge also stands at a lower level than the others, the antero-posterior ridges sloping down from the summit of the cusps to meet it.

Alternating with the ridges are two cavities of which the foremost is smaller and shallower than the hinder one. The latter is not only deeper but stands at a lower level than the rest of the crown. A small fold runs into the front cavity from each of the cusps. The hinder ridge and the cavity in front of it may be known as a talon.

This tooth differs markedly by its greater breadth in proportion to its length from the Gorilla, Orang, Gibbon, *Dryopithecus* and *Pliopithecus*. Man does not differ from it so much as the other genera mentioned, but the difference is still marked. The Chimpanzee varies, but its pm_4 has often an extremely high breadth index. The nearest resemblance in structure to pm_4 of *Sivapithecus* is, however, to be found in the corresponding tooth of the Gorilla.

---

[1] The breadth of pm_4 has been measured at right angles to the axis of the jaw, which at this point tends outward, away from the molar portion. If it were measured at right angles to the axis of the molars the breadth would be 10·4 mm.

The higher breadth index distinguishes *Sivapithecus*, although the recent genus seems subject to some variation in this character. The two inner angles of the tooth in *Sivapithecus* are less rounded than in the Gorilla, and in the recent genus the talon is more pronounced, therein approaching the Orang, Chimpanzee, Gibbon, *Dryopithecus* and *Pliopithecus*. The length of the talon and the corresponding length of the tooth is evidently a primitive condition, which is seen even more plainly in the catarrhine monkeys, in which the talon consists of two distinct cusps. *Sivapithecus*, therefore, shows a distinct approximation to Man.

Front lower premolar.—As this tooth is known only by its alveolus, it is impossible to form very exact conclusions as to its structure. It was of considerable size and two-rooted, the hindermost root being as broad as the posterior root of pm_4 and equally compressed antero-posteriorly. The foremost root is on the contrary compressed transversely and is situated to the outside of the hinder root to the extent of half the long diameter of the latter. The antero-posterior diameter of the tooth as estimated by its roots was approximately 12·6 mm. This tooth thus seems to agree in shape with that of *Dryopithecus* and the Gorilla. The pm_3 in the Orang is rather shorter, and the anterior root is situated further to the outside of the posterior root.

In the Chimpanzee this tooth is smaller in proportion to the rest of the dentition, and the two roots have a tendency to fuse; the anterior root, however, lies less to the outside and its breadth index in this genus is, therefore, lower than in the others. In the Gibbon the anterior root is only slightly displaced to the outside of the posterior one and pm_3 is therefore longer and narrower than in any of the others. In Man, however, the breadth index of pm_3 far exceeds that of any of these other genera and in him alone, moreover, it is one rooted and approximately rectangular.

The lower canine.—This was evidently a large tooth, the diameter of its alveolus being about 10 mm. There is no diastema between it and pm_3 and it lies wholly on the inside of that tooth as mentioned before.

Additional specimens from Haritalyangar.

Since the preceding portion of this paper was written, in fact, when the whole of it had been already sent to press, two additional fragments of a Primate mandible were discovered amongst the material which Sub-Assistant Vinayak Rao collected at Haritalyangar in beds which probably belong to the Nagri zone and are, therefore, slightly newer than those of Chinji, whence the type mandible of *Sivapithecus indicus* was derived.

There seems little doubt that these belong to the same genus and possibly the same species as the Chinji types, but in that case their owner must have been a slightly larger individual than the latter. It is worth noting as evidence of the absence of bias that before the existence of them was known to me I had provisionally referred a lower m_1 obtained at Haritalyangar to the same species.

Although the recent discovery has hardly necessitated the altering of a single word, yet its importance can not be overestimated, as confirming the conclusions drawn from my examination of the type mandible, and disposing of any objections, which might conceivably have been raised to them on the score of the specimen being pathological or deformed by pressure.

Symphysis.

The first of these additional specimens (Ind. Mus. D. 189) is a portion of the left ramus of the mandible, containing the canine, the roots of two incisors and of the front premolar, and showing the front and back surfaces of the symphysis, being broken at the base 36·5 mm. below the base of the crown of the canine. The correct orientation of the fragment in the horizontal plane is settled by the position of the root of the front incisor, and in the vertical plane by the base of the crown of the canine, apart from the analogy from all other Primates in regard to the direction of the cusp of the canine relative to the horizontal axis of the jaw. In considering the Chinji ramus and the Haritalyangar symphysis as parts of the same mandible, there is a limit to the amount of forward tilt, which can be allowed to the canine in the latter, determined by the position of the canine and the curve of the inner side of the ramus in the former of these two fragments. In constructing the ideal restoration, figured on pages 36 and 37, this limiting value has been chosen. We gather, therefore, that not only was the backward slope of the hinder symphysial surface very slight, with an entire absence of any shelf and passing abruptly back laterally into the body of the jaw, but also that the front surface of the symphysis was almost vertical for a considerable distance. At the very margin of the fragment, there is the slightest indication of a backward curvature. This front surface from the canine to the front incisor is slightly concave both laterally and vertically. The angle between this latter portion and the side of the ramus adjoining pm_3 forms an obtuse angle, considerably removed from the right angle which we find in the anthropoid apes. The approach to a human conformation of this part of the jaw may be realised when it is stated that the anterior root of pm_3, the front half of the canine, and the second incisor are in a straight line, forming an angle of only 20° with the line joining corresponding points on the two rami, as against the curvature of this line in the anthropoid apes, with an approximate average value of 60° for the same angle. There is a prominent foramen in front, near the median line, about 19 mm. below the approximate position of the neck of the first incisor. Such a foramen is occasionally found in the Orang about halfway between the tooth alveoli and the base of the jaw.

On the hinder face of the symphysis about 19·5 mm. below the base of the crowns of the front teeth the surface curves backward slightly towards the median line of the symphysis. In following the surface vertically from above downwards, near the median line it takes a slight bend backwards at the same point, but below this it evidently bends forward again, as can be seen from the surface of the jaw preserved nearer the basal margin but a little to the left of the median line. This would seem to indicate the presence in some degree of a *spina mentalis* in this position, similar to that of modern Man, but in any case a conformation of the hinder face of the symphysis altogether different not only from the apes but also from that of the famous Heidelberg mandible. This is shown in fig. 1 d of Pl. II.

From the above it is evident that the rami must have diverged very considerably, in as great a degree in fact as in Man. The last two molars, as shown by the type mandible, do not lie within the line of the other teeth as they do in man. Consequently the distance between the condyles must have been considerably greater than in any human jaw.

The depth of the symphysis and of the jaw, at all events in its front portion, is, thus, very great in proportion both to the size of the molars and to the united length of the tooth series in the type ramus. This is entirely in accord with the inference drawn from the low position of the mental foramen in the type ramus, with reference to the base of the crowns. This is one of the characters of the mandible of Krapina man, in which this dimension is much in excess of what obtains in other palæolithic types. It is noticeable that Krapina man also agrees with *Sivapithecus* in regard to the distance between the condyles, in which, however, it falls considerably short of the fossil Indian genus.

The stoutness of the jaw, as measured by the ratio of the height at the mental foramen to the thickness at the same point, is rather less than the mandibles of Chapelle-aux-Saints and Heidelberg. The former of these two measurements in the Haritalyangar species can hardly be more than 39 mm. and the latter is about 19 mm., which gives the ratio as 48·7 compared with 52·9 for the Heidelberg jaw, 50 for that of Krapina and 42 for that of a modern negro.[1]

Lower canine.—The lower canine is a conical tooth, having the following dimensions : height of crown 19·0 mm., length 13·9 mm., breadth 10·2 mm. It more nearly resembles the lower canine of the Gibbon than that of any other anthropoid known to me; there is a very distinct indication of a posterior cusp or heel, although the hinder edge of the tooth is so deeply worn by contact with the upper canine that it is impossible to say exactly how prominent this cusp was. The external side of the root, however, exhibits clearly a hollow which is continued up the crown, pointing to the former existence in some ancestral type of a strongly developed hinder cusp on a separate root.

Such a heel is present in the Gorilla, the Orang and the Chimpanzee, but very much feebler than either in the present species or in the Gibbon. In Man it is apparently absent, though even in this case the basal bulge on the internal side of the crown may be a remnant of an original cusp which has been displaced due to lateral shifting of the tooth. A sort of triangular facet is present at the base of the crown internally, the apex of which seems to be prolonged into a narrow ridge running up the crown, although the fracture of the internal upper quarter of the crown does not allow this feature to be followed to the summit. Posteriorly, the upper margin of this facet is continued as a faint cingulum backward and downward to the hinder heel.

Incisors.—These, as shown by their roots, are elongate in a direction parallel to the axis of the jaw and very narrow laterally. The distance from the internal margin of the canine to the median line measured through the incisors is 13·7 mm. The dimensions of the first incisor are: length 6·6 mm., breadth 3·8 and of the second incisor: length 9·3 mm., breadth 4·7.

---

[1] These measurements are taken from Boule, L'Homme fossile de la Chapelle-aux-Saints, *Annales de Paléontologie*, vol. VII (1912), p. 82.

Front lower premolar.

The second of the two specimens from Haritalyangar (Ind. Mus D. 190) is a left lower pm_3, the correct orientation of which is clearly proved by the existence of a facet on the inner hinder edge, caused by the contact of pm_4, and by the preservation of the outer portion of the alveolus of the same tooth, while on the antero-internal margin can be seen a part of the alveolus of the canine. The roots, when so placed, correspond identically with those of pm_3 in the type mandible described on page 41, and also, as far as can be judged, with those of the same tooth in the Haritalyangar symphysial fragment.

Thus placed the tooth may be described as being very broad in proportion to its length, with a very convex outer surface passing back gradually, without any abrupt change in the contour, into the straight hinder wall. The inner wall of the tooth forms a very acute angle with the hinder wall and proceeds obliquely towards the outside, where it forms an equally abrupt angle with the outer wall of the tooth, only in this case the angle is a right angle. Thus the actual front wall of the tooth is reduced to the width of a narrow ridge. The main cusp is situated in the centre of the tooth, and is connected by a sloping ridge to a faint secondary cusp directly internal to it, while a second ridge runs from the summit directly forward to the front point of the tooth. On its hinder side the former of these ridges falls abruptly into a hollow bounded by the raised posterior edge of the tooth and on its anterior side equally abruptly into another much smaller hollow just internal to the ridge which runs forward from the summit. A slight cingulum may be present externally, but in any case it is obliterated in the present instance by a strong area of wear at the antero-external corner of the tooth. The structure of this tooth is thus comparable with pm_3 in the Gorilla and the Orang. It differs from them—

(1) by its much greater transverse diameter and corresponding diminution in length,

(2) by the bicuspid character of the transverse ridge.

In respect of the second of these it agrees with the Gibbon and with Man. In the former genus pm_3 is much more elongated antero-posteriorly and is very narrow, while in the latter the breadth index is even greater; further, the tooth is one-rooted, much smaller and more rectangular in shape, the crown is less elevated and the internal cusp much more clearly defined, approximating in size to the main one and separated from it by an almost continuous antero-posterior valley.

Deductions as to upper dentition.

From these two specimens it is possible to deduce some information with regard to the structure of the upper jaw.

It is clear that the wear on the hinder portion of the lower canine and on the antero-external corner of pm_4 are both due to the attrition of the upper canine, which would, therefore, show signs of wear slightly to the inside and to the outside of its front margin, but posteriorly and on the greater portion of its internal side the wear would be *nil.*

This point is of interest as affording an important distinction from the apes, and will be referred to later in discussing the possibility of the maxilla of *Palaeopithecus* belonging to the same genus as *Sivapithecus.*

The upper canine must have bitten slightly inside the lower canine in order to produce this wear, at the same time it must have been situated internally to pm_3, otherwise the upper and lower teeth series would not be in the same line. Moreover, there must have been a considerable amount of lateral movement in the lower jaw, to account for such intense wear in two teeth situated in the position which the lower canine and front premolar of *Sivapithecus* occupy.

Unlike Man, the canines interlocked, which was also the case in *Eoanthropus.* In the latter genus, however, the fact that the upper canine worked wholly on the internal side of the lower canine seems to imply the absence of a diastema in the upper jaw between the canine and the incisors, an inference, which Smith Woodward has in fact drawn in his reconstruction of the upper jaw.[1] On the other hand, it seems equally certain that *Sivapithecus* must have had a diastema in the upper jaw.

---

[1] See, however, the remark on page 51 below, regarding the possibility that the canine of *Eoanthropus* belongs to the upper dentition. This, if true, may necessitate some revision of Dr. Smith Woodward's view as to the absence of a diastema in the upper jaw.

Lower molar.

A lower molar (Ind. Mus. No. D. 178), which may be referred to the present species, was also found in the same beds at Haritalyangar.

Its dimensions are as follows: length 11·9 mm., breadth 10·9, height 5·9, breadth index 91·6. It is in a very advanced stage of wear but shows the simplicity of structure, the inward displacement of the mesoconid and the absence of a cingulum, which are characteristic of *Sivapithecus*. Its breadth index is nearer to that of the latter genus than to any other, and its dimensions agree fairly well with those of the m_1 in the just described mandible, though it must have belonged to a slightly larger individual.

Upper molars.

A final fragment from Haritalyangar contains the much worn m^1 and m^2. These, though obviously Primate, are, probably, generically indeterminable. Their dimensions in millimetres are as follows :—

M^1	Length	10·5
	Breadth	13·5 (?)
	Breadth index	128·5 (?)
M^2	Length	12·5
	Breadth	14·0
	Breadth index	112·0

The absolute size and breadth index of these teeth agree well with those of the corresponding teeth in the type mandible of *Sivapithecus indicus*. The crown pattern of both teeth is, however, so entirely obliterated by wear and by dental decay that it is impossible to distinguish any similarity of structure to the lower molars of *Sivapithecus*. I should, indeed, be unwilling to deny that they might belong to a species of *Palaeopithecus*, slightly bigger than *Palaeopithecus sivalensis*, although the breadth index of m^1 is much greater than that of the corresponding tooth of *Palaeopithecus sivalensis*, which militates against generic identity.

Upper canine.

The most recent specimen to be discovered, which may be provisionally referred to the genus *Sivapithecus*, is an upper canine, which I found amongst a collection of fossils from the Lower Siwaliks of Chinji. Though apparently Primate, it differs considerably from that of any other genus so far known by the presence of a very distinct cingulum at the postero-internal corner of the tooth. Associated with this is a kind of longitudinal striation, producing a faint crenulated edge to the cingulum, and thence running up a short way in the direction of the summit of the tooth. The cingulum ends in the prominent posterior ridge, which runs up to the summit. There is also an anterior ridge, not so strongly marked. On the inner side of the latter is the usual deep groove seen in Primate upper canines, caused by the abrasion of the lower canine. The two ridges divide the tooth in a vertical plane into two unequal portions, of which the outer is the smaller and has a surface only very slightly convex, while the inner one is the larger and is very strongly convex. The dimensions of this tooth are as follows :—length 16·2 mm., breadth 10·6, height 19·4. The closest parallel to the structure of this tooth is to be seen in the upper canine of the *Cebidæ*. It also is possible that something of the same kind is present in the upper canine of *Pliopithecus*. The cingulum is possibly the remnant of a primitive cusp on its way towards atrophy.

Comparison with other genera.

Considering this mandible as represented by the fragments from Chinji and Haritalyangar, which have been described, there can be no doubt as to its claim to generic distinction. It remains to summarize its affinities with and differences from other Primate genera.

First attention should be called to the great excess of length of m_3 over m_2, the difference being, in fact, greater than in any other genus except *Pliopithecus*. *Dryopithecus punjabicus* does not fall so far behind it in this respect. It is very probable that this is a primitive character.

Although the living anthropoid apes agree with man in the equality or excess of length of m_2 as compared with m_3 yet they differ from him in the relations of length which obtain between m_1 and m_2. In Man m_1 is longer than m_2 whereas in the other genera the reverse is the case. *Sivapithecus* also differs from man in this respect. Considering the breadth index of the various molars, whereas we find that in *Dryopithecus* this increases regularly from m_3 to m_1, in Man and the living anthropoid apes the breadth index of m_2 is greater than that of any of the other molars. *Sivapithecus* agrees with the living genera in this.

Other differences between *Sivapithecus* and *Dryopithecus* are as follows:—

1. The greater breadth of the molars.
2. The simpler structure of the tooth crowns, the absence of secondary cusps, smaller degree of folding and the greater elevation of the main cusps.
3. The greater displacement of the mesoconid to the inside.
4. The short symphysis.
5. The bending outward of the front of the mandible and the consequently greater distance between the rami.
6. The inward position of the canine and the shifting backward of the whole of the incisor portion of the jaw.
7. The greater simplicity and larger breadth index of the last premolar, pm_4.
8. The greater breadth of pm_3 in proportion to its length than is the case in *Dryopithecus*, its bicuspid character, distinct though slight in *Sivapithecus*, and the transverse position of the ridge uniting the two cusps, as contrasted with the oblique direction of the corresponding ridge in *Dryopithecus*.
9. The more vertical front face of the symphysis and its more abrupt passage into the lower margin of the mandible.

The points in which *Sivapithecus* differs from the Gorilla and the Orang are the following:—

1. The greater breadth of the molars.
2. The greater inward displacement of the mesoconid.
3. The short symphysis.
4. The inward position of the canine.
5. The outward bending of the premolar portion of the jaw.
6. The shorter premolars.
7. The more vertical front face of the symphysis and its more abrupt passage into the lower margin of the mandible.

From the Orang it differs in addition by the absence of the characteristic rugosity.

From the Gorilla it differs by—

(1) the much lower cusps.
(2) the bicuspid character of pm_3 and the transverse direction taken by the connecting ridge.

From the Chimpanzee it differs by all the above except 1, and in addition by the higher cusps and the coarser nature of the folding of the enamel.

In certain respects *Sivapithecus* is nearer the Gibbon than it is to any of the other living apes. The chief of these are the short symphysis, which is however shorter than in the Gibbon, the hinder cusp in the lower canine, the bicuspid character of pm_3, the inward position of the mesoconid in the molars. The significance of these special characters common to *Sivapithecus* and the Gibbon, is discussed on page 61.

The differences between the Gibbon and *Sivapithecus* are striking and may be summarized as follows:—

1. The greater breadth of the front molars in *Sivapithecus*. On account of the degeneration of m_3 in the Gibbon, which has not occurred in *Sivapithecus*, that tooth often has a shorter breadth index than is the case in the fossil genus.
2. The much greater length of the premolars in the Gibbon, and the greater height and distinctness of the internal cusp in pm_3.
3. The extreme smoothness of the enamel in the teeth of the Gibbon, and the entire absence of the wrinkling which is to be seen in those of *Sivapithecus*.
4. The outward bending of the premolar portion of the jaw in *Sivapithecus*. This may be correlated with the increased breadth of the jaw.
5. The symphysis is still further shortened in *Sivapithecus*, and there is an entire absence of the shelf, which in the Gibbon lies internal to all the teeth in front of m_2.
6. Thus the rami, instead of coming almost to a point as they do in the Gibbon, pass into a broad rounded margin.
7. The greater depth of the ramus and of the symphysis in *Sivapithecus*.
8. The more vertical position of the front face of the symphysis in *Sivapithecus*.

In all the respects in which *Sivapithecus* differs from the living anthropoids, *Dryopithecus* and *Pliopithecus*, it either resembles Man or makes a decided approach to the conditions which exist in the latter.

In regard to the outward curvature of the premolar portion of the mandible, nothing of the kind is seen in Man, but it certainly seems to me, as has been stated above, that the existence of such a curvature must necessarily be correlated with a greater distance between the rami than exists in any other anthropoid genus than Man. This opinion is confirmed by the examination of the symphysial fragment from Haritalyangar. Agreement with man is shown by the degree of elevation of the cusps, by the nature of the folding, and in the comparative simplicity of structure.

The last two molars in Man, however, generally show a reduction in the number of cusps. Further, the large canine with its posterior heel, the longer pm_3, in which the bicuspid character of the transverse ridge is very much less pronounced, and the greater complication of the premolars generally are not human characters.

The different shape of the mandible in *Eoanthropus* from that of *Sivapithecus* has been mentioned above (page 38). We need not necessarily assume that the restoration of the premolars and of the upper portion of the jaw in advance of the molars is precisely as Smith Woodward has imagined it; it seems quite possible that the premolars may have approximated more nearly in shape and size to those of *Sivapithecus*. In this connection it may be remarked that A. E. Anderson[1] considers that the canine tooth, last discovered at Piltdown, belongs to the upper and not to the lower dentition, as determined by Smith Woodward. If it be an upper canine, then the peculiar condition of wear indicated that the front lower premolar, which caused it, must have been elongate and prominent, in fact much more like the pm_3 of the living apes and of *Sivapithecus*. At the same time it seems certain that there was no outward curvature of the ramus in the premolar region, and probable that the canine lay more in advance of pm_3 than is the case in *Sivapithecus*. The two genera agree in the simple structure of the molars. Their points of difference may be summarized as follows:—

1. The longer symphysis of *Eoanthropus*.
2. The absence of the outward curvature of the premolar region in *Eoanthropus*.

---

[1] *American Museum Journal*, New York, September 1914.

3. In *Eoanthropus* the canine is smaller and does not possess the posterior heel which is found in the canine of *Sivapithecus.*[1]
4. In *Eoanthropus* the lower canine is probably situated in advance of pm_3 instead of being internal to it as in *Sivapithecus.*
5. The inferior depth of the ramus anteriorly in *Eoanthropus.*
6. The much narrower teeth in *Eoanthropus.*
7. The smaller premolars of *Eoanthropus,* possibly more marked in the case of pm_3.[1]
8. The reduction in length of m_3 as compared with m_2 in *Eoanthropus.* This has not taken place in *Sivapithecus.*
9. The internal wear of the lower canine[1] in *Eoanthropus,* as opposed to the posterior zone of wear in *Sivapithecus,* indicates the absence of a diastema in the former genus between the upper canine and the incisors, in the presence of which *Sivapithecus* probably agreed with the apes.
10. Probably in *Eoanthropus* the front face of the symphysis retreats more than in *Sivapithecus.*

In considering the propriety of referring this mandible to the genus *Palaeopithecus,* we labour under the disadvantage of knowing only the maxilla and upper teeth of the latter genus. Since, however, I am disposed to believe that the height of the cusps and the amount and character of the wrinkling did not materially differ in these two genera, and since in *Palaeopithecus* we find an exceptionally high breadth index for the upper molars just as we do in *Sivapithecus* for the lower ones, it will be as well to mention in detail certain features in the mandible of *Sivapithecus,* which seem incompatible with such a maxilla as *Palaeopithecus* possessed.

1. The outward curvature of the premolar portion of the mandible in *Sivapithecus* could not have been associated with such a maxilla as that of *Palaeopithecus,* as in that case the upper canine would have been opposed to or internal to pm_3, instead of biting outside it.

2. This outward displacement of the premolars in *Sivapithecus,* united with the inward position of the canine, must inevit-

---

[1] See, however, the above suggestion that this tooth is the upper canine of *Eoanthropus.*

ably have accompanied a backward divergence of the mandibular rami, resulting in a breadth of jaw, which is quite incompatible with the narrow palate of *Palæopithecus.*

3. The inward position of the canine argues a backward shifting of the incisors, so that even supposing the right and left upper tooth series to be parallel as they are in *Palæopithecus*[1] the angle between the upper molar series and the incisor series would more nearly approach a right angle than is the case in *Palæopithecus.*

4. The reduction, which has taken place in the front portion of the cheek teeth series in the maxilla of *Palæopithecus*, is unlikely to have occurred in the maxilla of *Sivapithecus*, judging by the extraordinary dimensions of pm_3 in the mandible of the latter genus.

5. The considerable shortening of the symphysis in *Sivapithecus* from its assumed primitive condition, and the widening of the jaw in the direction followed so markedly in the *Hominidæ*, probably must be correlated with a palate more concave anteriorly than is the case in that of *Palæopithecus.*

6. On page 46, from the observation of the zones of wear on the lower canine and the front premolar from Haritalyangar, considered in connection with the position of the canine with reference to pm_3 and the incisors, I have predicated certain features which might be expected in the maxilla and especially in the upper canine; *Palæopithecus* does not fulfil these, since its upper canine shows a distinct zone of wear posteriorly, such as would be produced by a pm_3 situated immediately behind the lower canine, a position quite at variance with that of the corresponding teeth in the mandible of *Sivapithecus.*

From *Pliopithecus* the present genus is distinguished by its broad molars, by the wrinkling of the enamel, by the absence of the cingulum, by the greater length of the premolars, by the larger canine, and by the short symphysis. It is probable that *Sivapithecus* agreed with it in the backward divergence of the mandibular rami.

Sivapithecus differs from *Propliopithecus* in respect of most of the features which distinguish it from *Pliopithecus*, with the exception of the short symphysis. The molars of *Propliopithecus* are, however, much broader than those of *Pliopithecus*, and in the case of m_1 the breadth index exceeds that of the corresponding tooth of *Sivapithecus*

---

[1] Such a supposition, unlikely enough before, is now definitely negatived by the discovery of the symphysial fragment from Haritalyangar (Ind. Mus. D 189).

The breadth index of the premolars is less, while pm_3 is a much smaller tooth proportionately to the size of the jaw than in *Sivapithecus,* the canine is much smaller, m_3 shows a reduction in length, and the front of the jaw was probably much narrower.

As *Pithecanthropus* is not known by any portion of the mandible or by lower teeth, no comparison is possible with the Miocene genus. The great degeneracy of the last upper molar and the considerable amount of wrinkling of the enamel, militate against generic identity.

EVOLUTION OF THE ANTHROPOIDEA.

It may not be out of place to discuss the bearing of these new discoveries on the question of the evolution of the Anthropoidea and the relation of Man to the Simian stock.

The remarkable characters possessed by the mandible of *Sivapithecus,* which, as we have seen, ally it in many respects rather to Man than to any of the *Simiidæ,* lead us at once to enquire whether the evidence is strong enough to place *Sivapithecus* on the direct line to the *Hominidæ.*

From the material previously at our disposal it might, I think, be justly concluded that the long and deep symphysis, which is present in all recent apes except the Gibbon and also in *Dryopithecus* and *Pliopithecus,* is a later development from a primitive short and shallow symphysis, such as we find in the lemuroids and many other mammalia and also in the immature mandibles of forms which in the adult stage have long symphyses, implying a descent from ancestors with a short symphysis. The primitively short symphysis is seen in the earliest known member of the Anthropoidea, *Propliopithecus* from the lower Oligocene of the Egyptian Fayum. The extreme shortening of the symphysis seen in Man is as obviously a special development. We may thus conclude with certainty that *Sivapithecus* should take its position somewhere on the main line, from which diverged the cluster of genera which developed a long and deep symphysis, of which *Dryopithecus* is the earliest and perhaps the most typical so far as concerns this particular feature. We have, however, to decide whether the place of *Sivapithecus* on this main line should be before or after this divergence. From the combined evidence of the two mandibular fragments, from Chinji and from Haritalyangar, we may safely conclude that *Sivapithecus* has left the primitive condition and has begun that excessive shortening of the symphysis which is characteristic of Man. This opinion seems to find support in the co-existence of other characters in *Sivapithecus*, which are not found in the *Dryopithecus* to Gorilla line, but which I shall try and show approximate to certain human features.

The outward curvature of the premolar region of the mandible is certainly peculiar to *Sivapithecus*, but, in my opinion, it involves the co-existence of a breadth of jaw and a degree of separation of the mandibular rami which is essentially peculiar to Man. I would suggest that the outward curvature of the premolar portion of the mandible with its accompanying backward shifting of the incisor region was the first attempt to widen the jaw, that the gradual moving outward of the premolar region was succeeded by a corresponding outward movement of the molar region. We, no doubt, have in the present species of *Sivapithecus* a degree of premolar displacement which no ancestor of Man could have possessed, since a displacement of the molars sufficient to bring them into line with the premolars would result in a breadth of jaw far greater than is found in Man. But it may well be that Man has descended from a marginal species of *Sivapithecus*, in which this premolar displacement was less intense. Once begun, as seems to be the case in many other instances, such an adaptation sometimes tends to become exaggerated, but there is no reason to suppose that it became equally exaggerated in every other species of *Sivapithecus*.

With equal or greater justice it might be contended that the short bicuspid pm_3 of Man could not have been evolved out of the pm_3 of *Sivapithecus*, where the internal cusp is no more than a slight prominence on a transverse ridge sloping downward internally from the summit. If, however, we are willing to admit that the bicuspid character of pm_3 is a later development from a primitively unicuspid tooth, there should be nothing discordant in the fact that a sarmatian ancestor of Man does not show the bicuspid structure as plainly as his more modern descendants. Indeed, if both the cusps in the pm_3 of *Sivapithecus* were rather lower and the inner one were a little farther removed from the main one, it would be little different in essential features from that of Man. A species possessing such a pm_3 might easily be included in the genus *Sivapithecus*, and then an inward movement of the external face of the tooth and especially of the antero-external angle, accompanied by a general diminution in size of the whole tooth and atrophy of the anterior root would lead to a type identical with that of modern Man.

Amongst the teeth of Krapina man, figured by Gorjanovic-Kramberger[1], is a pm$_3$ which shows a very decided approach to the hypothetical condition described above. That specimen is triangular in shape, is strongly developed on the external side, and the inner and outer cusps are connected by a ridge, which is not only prominent but also oblique.

That the front premolar in the Primates was originally unicuspid, may be conjectured from the fact that the modern representatives of the more primitive family of the *Cercopithecidæ* all possess a single cusp to pm$_3$. The same is the case in the Lemurs. Further, none of the fossil types show any trace of a second cusp, if we except the vestigial one which Schlosser records in *Propliopithecus.* The latter genus shows evidence in other ways of being on a line which developed precociously in the directions followed by other lines in much more recent times. The Eocene Primates exhibit a very distinct heel in the premolars, but no trace of a cusp internal to the main one. Such an inner cusp is a well marked and fairly constant feature in the Gibbons, but we have no reason to suppose that it dates back from any more remote period than the Pliocene. Slight traces of this second cusp in pm$_3$ are occasionally met with in the Gorilla, Orang and Chimpanzee.

The *Cebidæ,* it is true, have this inner cusp in pm$_3$, but in many respects they are an extraordinarily advanced family. Moreover, it must be remembered that in this family there are three lower premolars, and this fact may, for physiological reasons, have led to the early molarization of pm$_3$.

On the whole, then, it seems that we may consider it possible that the human ancestor might have belonged to the same genus as the mandible of *Sivapithecus indicus.* We must of course be prepared for such a hypothetical Miocene human ancestor, when found, proving to be in the process of evolving a broad jaw by a rather different way, or to be too near Man to make it possible to include it in the genus *Sivapithecus.* In this case *Sivapithecus* would not be on the main line of man's ascent but would represent a special adaptation. For the present, however, I prefer to consider the human ancestor as a marginal species of *Sivapithecus*. This is represented in the accompanying table in Plate 4 by the line to Man passing through the end of the name *Sivapithecus* and not through the middle of it.

---

[1] Gorjanovic-Kramberger, Der diluviale Mensch von Krapina, *Mitt. d. Anthr. Gesells Wien.*, vol. XXXI, p. 190, Pl. III, fig. 3.

The characters by which *Sivapithecus* differs from Man and resembles the apes or *Dryopithecus* do not militate in the least against such a view, since these are obviously primitive characters, and there is absolute proof that many of them were but lately acquired by the human stock. Such characters are the large canine, which has been shown to occur even in a genus possessing skull characters so nearly resembling those of Man as *Eoanthropus*. Certain of the primitive Australian races have a slightly larger canine than is the case in normal mankind. The same is true of the Palæolithic species, *Homo neanderthalensis*. Moreover the milk canines of modern Man exhibit amongst the various features, which distinguish them from the permanent canines and which have been detailed by Smith Woodward,[1] that of slightly superior size. The question of the hinder cusp of the lower canine, by which *Sivapithecus* agrees with the apes and especially with the Gibbon and differs from Man is discussed on page 59. It seems likely that this is also a primitive character, and that its gradual atrophy has taken place on more than one line. The chin, which is such a striking feature in the jaw of modern Man, is wanting in some of the more ancient Palæolithic types; hence the fact that *Sivapithecus* does not possess it proves only that that genus is in an early stage of development. The increasing length of the molars as we go backward in the jaw is found in many of the fossil *Hominidæ*, and does not prove any near affinity of *Sivapithecus* to *Dryopithecus*. The recent apes have proceeded along the same lines as regards this reduction in size of the back molars. The loss of the mesoconid in the human m_3 is equally a case of late degeneracy found in the Gibbon and Chimpanzee as well as Man. In Man however this degeneracy has involved m_2 as well as m_3. The large breadth index of the *Sivapithecus* molars as well as its diminution going from m_2 to m_1 may, however, be taken as evidence that *Sivapithecus* has reached a further stage of development than the primitive Dryopithecoid ancestor, hence that the former genus stands on the main line to Man long after the divergence of *Dryopithecus* had taken place.

Stress may also be laid on the resemblance between the molars of *Sivapithecus* and m_1 of Man, which has not degenerated like the two hinder molars. The position of the mesoconid, the general simplicity of structure, the higher cusps, and the coarseness of the folding seem to approximate to similar features in the human stock. The reduction of pm_4 also recalls what has occurred though to a greater degree in Man. The large pm_3 would seem to be a primitive character, judging from the similarly large pm_3 in the *Cercopithecidæ* and the Lemuroids, and by the reduction of the same tooth in the Chimpanzee and the Orang.

---

[1] Smith Woodward, Supplementary note on the discovery of a palæolithic human skull and mandible at Piltdown. *Quart. Jour. Geol. Soc. Lond.*, Vol. LXX (1914), p. 91.

A comparison of the mandibles of *Sivapithecus* and *Eoanthropus* seems inevitably to suggest that the latter genus is farther removed than the former from the direct line of human ancestry. The longer symphysis, in which there is certainly no trace of any shortening comparable with that which has taken place in Man, the narrower teeth and the position of the canine, entirely in advance of the premolar series, seem to be primitive characters, which have been retained by the Pleistocene genus *Eoanthropus*, though lost in the Middle Miocene *Sivapithecus*. The human characters of the skull of the former are sufficient reason for assigning it a place on the line of the *Hominidæ*. It necessarily follows that the two lines of *Eoanthropus* and *Sivapithecus* diverged long before the appearance of the latter genus.

The reduction of pm_3, m_3 and possibly of the canine are features of an advanced stage of evolution in the Anthropoidea, such as might be expected in any Pleistocene anthropoid genus quite independently of its particular line of descent.

Before finally deciding the respective claims of these two genera for a position on the direct line to Man, we must investigate the structure of the lower canine, which may tell altogether against the conclusion to which I have so far been leading.

As has been described, the lower canine of *Sivapithecus* seems by the possession of a hinder heel to be more like that of the Gibbon than that of any other of the anthropoids. This prolongation, however, occurs though less strongly in the Orang, the Gorilla and the Chimpanzee. Dr. Smith Woodward seems to imply, though he does not actually state it, that he infers from the fact that the milk canine in the apes does not show this hinder heel so markedly as the permanent canine that the heel is a later development in the race and that primitively the Primates were without it.[1] I hope I have not misunderstood him, but in any case if this were so, then, obviously' *Sivapithecus* could not have been ancestral to Man, since it would possess a character more advanced than in the latter. I think, however, that Dr. Smith Woodward would be the first to admit that undue stress must not be laid on the milk dentition as evidence of phylogenetic development and more especially on canines. On the other hand such a heel is found in the primitive *Cercopithecidæ* and *Cebidæ.* In *Pliopithecus* it actually takes the form of a basal cusp. Such a structure would be perfectly explainable if we accept the theory[1] that the canine was originally a premolar which has taken on the functions of the former. The heel would then be the remnant of the hinder cusp which is present in the premolars of Primates both primitive as well as advanced, this remnant being largest in the Gibbon, tending to disappear in Gorilla, Orang and Chimpanzee and having entirely vanished in Man. I think therefore that such a canine is what might be expected in a Miocene ancestor of Man.

---

[1] Smith Woodward, l. c., p. 91.

The obvious conclusion to be drawn from the facts is that *Eoanthropus* represents a collateral stem which did not lead to Man as we know him from any of the recent and most of the fossil types, being, so to speak, only one of Nature's experiments at producing the higher human type. An exception, possibly the only one, to this is seen in the mandible found in the Mauer sands, near Heidelberg, and described by Otto Schœtensack.[2] The symphysis and general structure of this famous relic remind us more of *Eoanthropus* than any other human mandible so far known. Boule suggested, indeed, that the two are specifically inseparable.[3] It has not been suggested, so far as I know, that the Heidelberg jaw should be ascribed to any other genus than *Homo,* but it is believed by many scientists that the species of *Homo,* which it represents, has no connection with modern Man. If my ideas as to the evolution of the anthropoid symphysis are sound, then we seem justified in going farther than this, and placing *Eoanthropus* on the line which led, possibly by degeneration according to Smith Woodward's view,[4] to Neanderthal Man, and *Sivapithecus* on that which led to modern Man.

---

[1] Compare M. Schlosser, Beiträge zur Kenntniss der oligocänen Landsäugethiere aus dem Fayum: Agypten *Beitr. z. Pal. u. Geol. Öst-Ung.*, Vol. XXIV (1911), p. 52, and see page 64 below.

[2] O. Schœtensack, Der unterkiefer des Homo Heidelbergensis aus den Sanden von Mauer bei Heidelberge. Leipzig, 1908.

[3] M. Boule, L'Homme fossile de la Chapelle-aux-Saints, *Annales de Paléontologie* vol. VIII (1913), p. 246.

[4] Smith Woodward, l. c., p. 139.

After all, when once we have admitted the polyphyletic origin of Man, this hypothesis only places the separation of the two or more branches of humanity rather farther back in the geological record.

A possible alternative to this theory is that *Eoanthropus* stands on the direct line to Man and that the shortening of the symphysis, the increase in width of the jaw, the backward shifting of the canine and incisors, and the broadening of the molars all have taken place since the beginning of the Pleistocene, while *Sivapithecus* is an instance of precociously developed human characters in a Miocene genus, which, nevertheless, evolved no further and did not proceed as far as Man.

On the whole the former of these two views seems preferable, since the period which has elapsed since the Middle Miocene seems ample for some marginal species of *Sivapithecus* to have undergone considerable reduction in regard to its canine, pm_3 and m_3, while, on the contrary, the long symphysis and narrow teeth of the Pleistocene *Eoanthropus* seem as if they could hardly have given rise to Pleistocene forms of *Homo sapiens*, or even of modern Man, in the required time.

There is indeed a third alternative that the human ancestor was on a third line, distinct from that of either *Eoanthropus* or *Sivapithecus*. This, though far from improbable, need not at present be considered as it entirely enters the region of guess work.

Accordingly it is the first of these views which I have tried to express diagrammatically in the table of descent forming Plate 4.

The Gibbon.

The short symphysis of the Gibbon is perhaps closer than that of any other of the living anthropoid apes to what I conceive to be the ancestral form, before its shortening in the *Sivapithecus* line or its lengthening in the *Dryopithecus* line had commenced. The symphysis has, undoubtedly, deepened considerably, and its front edge has become more vertical. It is even conceivable that it may have shortened, but in any case much of its primitive appearance has been retained. When to this we add the narrow palate and mandible, the simple, generally narrow teeth, showing neither cingulum nor crenulation, the elongate crown of pm_3, the strong hinder cusp in the lower canine, not to mention other characters which are not so much in question in the present paper, I see no other probable theory than that the Gibbon is the somewhat advanced representative of an ancient type more nearly allied than the other living apes to the original lemuroid stem, from which the *Sivapithecus*—Man and *Dryopithecus* lines diverged. It seems to me likely that these similar characters in the Gibbon and *Sivapithecus*, which we have good reason to believe are primitive, possess an important significance and indicate a closer connection to one another and to the original anthropoid stock for these two genera than is the case with the other living apes and *Dryopithecus*. Possibly also at an earlier date both the *Cebidæ* and *Cercopithecidæ* separated from the same primitive stock.

Pithecanthropus.

In deciding as to the position which *Pithecanthropus erectus*, Dubois, from Trinil in Java, is to occupy in our genealogical scheme, we are met with numerous difficulties, arising not only from the meagre nature of the material, but also from the doubt whether all of it should be referred to the same species. Assuming that the human features presented by the femur and the skull cap, as well as to a smaller extent by the fragmentary teeth, entitle this genus to rank as one of the *Hominidæ*, it seems to me that we should be quite prepared to find also features which it shares in common with the Gibbon ; these latter features it might owe partially to retention from a primitive gibbonoid ancestor, partially to development along the same lines as the Gibbons ; both of these suppositions are rendered easier, if the belief, which seems to the author so plausible, is accepted, that the human and Gibbon lines are more closely connected than those of other anthropoids. The gibbon-like affinities of *Pithecanthropus* were originally noticed by Dubois, and have later been discussed by other scientists, especially amongst the Germans. More recently Boule has seen in them a strong argument for removing *Pithecanthropus* from the *Hominidæ* and placing it on a special side branch of the *Hylobatidæ*.[1] The human characters of the Javan specimens he would then attribute to convergence. Although I am not prepared to deny this hypothesis, yet in view of the explanation offered above, it seems to me not only unnecessary, but improbable, when one takes into account the dimensions of the Javan remains, which greatly exceed those of the Gibbons, as well as the entire absence of evidence that many of the human characters of the teeth and of the calvarium ever developed on any other anthropoid line than that of Man. I am, therefore, inclined to consider *Pithecanthropus* as an early offshoot from some species of *Sivapithecus*.

---

[1] M. Boule, l. c., p. 263.

Pliopithecus and Propliopithecus.

Dubois has treated in detail the question of the affinities of *Pliopithecus* and has advanced cogent reasons for not accepting the general view that it is ancestral to the Gibbon[1]. I am in complete agreement with his conclusions. The differences between *Pliopithecus* and the Gibbon may be summarized as follows :—

1. The greater proportionate breadth of the teeth in the front of the jaw in *Pliopithecus*, particularly marked in the case of pm_3, but noticeable in all the premolars, upper as well as lower, and in the first molar above and below.
2. The much longer symphysis in *Pliopithecus.*
3. The greater divergence of the mandibular rami.
4. The unicuspid character of pm_3 in *Pliopithecus*, in contrast to the two cusps which this tooth possesses in the Gibbon.
5. The narrowness of the jaw in front, as shown by the much smaller united breadth of the incisors than in the Gibbon.
6. The much smaller height of the canines in the fossil genus.
7. Whereas in the Gibbon the depth of jaw increases from behind forward, in *Pliopithecus* the depth is uniform.
8. The greater elongation of m_3 in the Gibbon, and the more complicated talon of the same tooth.
9. The greater length of m_3 as compared with m_2 in the Gibbon.
10. The presence of a strong cingulum in the fossil genus which is absent in the Gibbon.

Of these 4 to 10, though, in my opinion, sufficient to justify generic separation, are not incompatible with the supposition, which appears to be generally held, that *Pliopithecus* represents an ancestral type from which the Gibbon directly descended, since we either may be certain or have strong reason to suppose that they are primitive characters : 10 may be primitive, but in any case we are not justified in regarding it as essential. On the other hand it seems impossible to suppose that a genus possessing characters 1 to 3 could have been on the direct line of ancestry of the Gibbon.

With regard to 1, most of the primitive Primate types, except the

---

[1] Dubois, Ueber drei ausgestorbene Menschenaffen. *Neues Jahrb. f. Min. Geol., u. Pal.*, vol. I. (1897), p. 97.

Cebidæ, possess long premolars, while in the modern anthropoids the length of these teeth is very decidedly less. Moreover such facts as are at our disposal regarding the course of development of the anthropoids, shown for example in the genera which fairly obviously may claim descent from *Dryopithecus* and in the prehuman genera *Eoanthropus* and *Sivapithecus*, lead us to imagine that the tendency has been for the breadth index of the premolars to increase rather than to diminish.

With regard to 2, nothing points otherwise than to the conclusion that such a symphysis as that possessed by *Pliopithecus* is a later development, seen in no single case amongst primitive Primate types.

Additional evidence in favour of the view here advocated is afforded by the Oligocene genus *Propliopithecus* from the Egyptian Fayum. Schlosser has expressed the opinion that this genus is so nearly allied to *Pliopithecus* that it can be regarded as its direct ancestor.[1] There seems to be hardly anything against this. It is, at all events, separated by so great a time interval from *Pliopithecus* that even if it be not its direct ancestor we may yet gather from it the direction of evolution followed in the *Pliopithecus* line. Accordingly we may note the short symphysis and the lesser divergence of the rami of *Propliopithecus* as supplying evidence in favour of the view set forth above.

The extremely large breadth index of all the teeth, but especially of the front premolars, is apparently opposed to it. Equally so, however, would the fact that m_3 is shorter than m_2. There can, however, be no doubt that the latter character is typical of an advanced stage of evolution. Consequently, I am of opinion that the large breadth index in the dentition of *Propliopithecus* is also a precocious development, and points to *Propliopithecus* being an early offshoot from the main *Pliopithecus* line, in which certain features, generally characteristic of a much later stage, have prematurely arisen. It may be observed that features of a precisely similar advanced type occur in the otherwise primitive family of the *Cebidæ*.

The question of the canines in this branch merits consideration. Are the small canines in *Propliopithecus* an instance of precocious reduction, similar to what has occurred at an extremely recent period in the case of the *Hominidæ*, or were the canines of the

---

[1] Schlosser, l. c., p. 54.

Anthropoidea primitively small? The answer to this can only be hazarded as a guess. One is, however, inclined to presume that the reduction of the canines in Man is too recent to be regarded as other than a physiological adaptation, associated with his upward progress towards civilization and possibly adoption of tools. Further the milk canine in the anthropoid apes tends to be smaller than the permanent canine, just the reverse of the condition observed in the milk canine of Man, which is larger than the permanent canine, suggesting that what occurs in the history of the individual, has also occurred in the history of the race; in each case it is the characters of its more recent ancestors which are reproduced in the milk dentition. Schlosser[1] has suggested that in the Primates generally the canine may have originated as a front premolar which gradually assumed a caniniform shape, the original canine coming to function as an incisor. This transformation is generally believed to have taken place in the Lemuroidea, and such a hypothesis for the *Simiidæ* would explain the small size of the canines in *Propliopithecus.* Even in *Pliopithecus*, which is the next oldest of the Anthropoidea to *Propliopithecus*, the canines are relatively small, but for the most part the various anthropoid lines must by that time have acquired canines of the normal type, assuming that originally they had small ones. Subsequently in the *Hominidæ* alone a recent reduction has occurred.

On this series of facts and deductions therefrom rests my conclusion that *Pliopithecus* cannot be on the main line of ascent to the Gibbon, but must have branched off at a comparatively early date, rapidly specializing on certain lines of its own and on other lines which were to be followed at a much later period by other groups of the anthropoid apes and Man.

The long symphysis, the outward position of the mesoconid and the more complex m_3 equally prohibit us from placing it on the *Sivapithecus* line and make it clear that it must, at all events, have started on the line of development followed more completely by *Dryopithecus.* On the other hand, the increase of the distance between the hinder portions of the two mandibular rami, the entire absence of wrinkling of the enamel and above all the reduction in length of the front portion of the ramus, including the front molar as well as the two premolars—a reduction which in a lower Miocene form is especially striking and significant—is entirely opposed to any idea of a long continuance on the *Dryopithecus* line. *Pliopithecus*, then, in my opinion represents an early offshoot from the line of *Dryopithecus* and the recent African apes.

---

[1] Schlosser, l.c., p. 54.

The same arguments, which have been stated above against the theory that *Propliopithecus* was the direct ancestor of *Pliopithecus*, apply equally against assigning to it any position on the lines to the *Gibbon* or to *Sivapithecus* and Man. There remains, therefore, the most probable supposition that it started on an early branch from the *Dryopithecus* line in common with *Pliopithecus*, but separated from the line of the latter genus almost immediately, specializing in the most remarkable way by the broadening of the premolars and the reduction in length of m_3.

Palæopithecus.

Palæopithecus is, unfortunately, known only by the palate and upper teeth. It is, however, evident that its narrow palate points to a primitive condition and, therefore, that the species must either be on the *Dryopithecus* line or be a later representative of a form which was on the main line previous to its division into the *Sivapitheous* and *Dryopithecus* branching. The small size of the incisors in this species is equalled only by that of *Dryopithecus*. Although the structure of the mandibular symphysis is unknown, yet the flatness of the front portion of the palate proves that no shortening of the symphysis, such as has taken place in Man and to a rather less extent in *Sivapithecus*, can have occurred. The most striking difference from *Dryopithecus* consists in the great breadth of the teeth. If this large breadth index were due to reduction from the hinder end of the series, as has taken place in the Orang and the Gorilla, then the first molar should have a smaller breadth index than the second and third. We do not, however, find this to be the case in *Palæopithecus*. Further, m^3 in *Palæopithecus* does not show many signs of advanced degeneration, and m^2 none at all. It would seem, then, that the teeth have broadened without degenerating. The large breadth index of the premolars as well as that of the first molar shows that the shortening has occurred in the anterior portion of the jaw. The condition, in fact, recalls that in *Pliopithecus*; this affinity has already been suggested by Dubois[1], and it certainly seems reasonable to regard *Palæopithecus* as a later and more advanced representative of a branch, from which *Pliopithecus* had diverged earlier. The vestigial cingulum is reminiscent of *Pliopithecus,* while on the other hand the folding of the enamel and the greater reduction of pm^3 are later developments. Judging by analogy with *Pliopithecus,* it is likely that *Palæopithecus* had an equally long symphysis.

---

[1] Dubois, l.c., p. 96.

Griphopithecus.

Griphopithecus, known only by the last upper molar, may conjecturally be placed on this line in virtue of its exceptionally large breadth index, unaccompanied by any particular reduction in the number or size of the cusps.

The Gorilla.

The Gorilla bears obvious signs of being descended from *Dryopithecus* by its narrow mandible, its long and deep symphysis, its elongated premolars, and its comparatively low breadth index. It was probably descended from a marginal hypothetical species of *Dryopithecus* with higher cusps and a lesser amount of wrinkling. Evidence for the existence of such a marginal species, may be found in the species *D. giganteus* and *D. chinjiensis,* the latter of which, indeed, might even be the direct ancestor of the Gorilla.

The Chimpanzee.

The Chimpanzee shows a reduction in the upper tooth series, greater than that of any of the other recent genera except Man; this is, however, a later development. The greater degree of wrinkling of the enamel and the lowness of the cusps would suggest that it is not on the same subsidiary branch from *Dryopithecus* as the Gorilla, and the broader mandible and shorter symphysis than *Dryopithecus* inclines me to the opinion that it sprung from an ancestral form, farther back on the main *Dryopithecus* line than the genus *Dryopithecus* itself.

Palæosimia and the Orang.

The existence of a last upper molar at the same horizon as *Dryopithecus,* which has an enamel so crenulated as to bear comparison only with the Orang, inclines us to consider its owner as the ancestor of the Orang. The structure of this tooth admits of a close comparison with *Dryopithecus,* but it is difficult to regard it as generically identical with the latter. It has, therefore, been assigned to a new genus, which has been called *Palæosimia.* The structure of the other teeth and of the mandible in *Dryopithecus* and the Orang are very similar. There are, however, differences in cranial structure from both the Chimpanzee and the Gorilla, which point to a lesser degree of specialization in the Orang. It is necessary, therefore, to consider

Palæosimia as branching off from the *Dryopithecus* line previous to the Chimpanzee and the Gorilla and passing through a marginal hypothetical species of *Dryopithecus.*

Pliohylobates.

Following Dubois[1], the affinities of the femur from the pontian beds of Eppelsheim may be considered to lie rather with the Gibbons, and that author's name for it of *Pliohylobates eppelsheimensis* has an equal right with Pohlig's *Paidopithex rhenanus* to be accepted as the name of the genus and species, since both were published at the same meeting.[2] Dubois' name appears to have attained a certain vogue, while Pohlig's name of *rhenanus* has been employed by Schlosser for a species of *Dryopithecus*, in which the Eppelsheim femur is included by that author. It seems better, therefore, to adopt the name of *Pliohylobates eppelsheimensis* for this specimen, as long as it continues to hold any title to separate generic and specific recognition.

Neopithecus.

As *Neopithecus*, Abel, (*Anthropodus*, Schlosser) is known only by a last lower molar its affinities are very obscure. On account of its low breadth index, and low cusps, accompanied by a folding of the enamel which is certainly less complicated than in *Dryopithecus*, and is no greater than in some early types of Man or in *Pithecanthropus*, I place it provisionally on a branch which left the *Eoanthropus* line at an early date, and has retained many primitive features of the anthropoid stock.

Anthropodus.

Anthropodus, Lapouge[3], being founded solely on an isolated upper incisor and a jugal, is too little known to be included in this phylogenetic survey.

---

[1] Dubois, l. c., p. 97.

[2] *Société Belge de Géologie, Pal. el Hydrol.* séance du 29th Oct. 1895.

[3] G. de Lapouge. Note sur un nouveau singe pliocène, *Bull. Soc. Scien. el Med. de l' Ouest*, du 4° trimestre 1894. Rennes, p. 202—208.

Table of dimensions and breadth indices of

—		Dryopithecus punjabicus.	Dryopithecus rhenanus.	Palæosimia rugosidens.	Sivapithecus indicus.	Palæopithecus sivalensis.	Pliopithecus antiquus.	Griphopithecus suessi.
M^3	Length	9·6	..	10·8	..	10·4	6·5	..
	Breadth	11·3	..	11·9	..	11·4	7·5	..
	Height	5·8	..	6·3	..	..	..	..
	Breadth Index . .	117·7	..	110·1	..	109·6	115·3	..
M^2	Length	10·6	10·4	..	12·5	12·0	7·0	8·5
	Breadth	11·4	11	..	14·0	13·1	8·0	10
	Height	5·6	4·3	..	..	..	..	..
	Breadth Index . . .	107·5	105·7	..	112·0	109·1	114·2	117·6
M^1	Length	10·4	9·6	..	10·5	10·9	6·2	..
	Breadth	11·3	10	..	13·5 (?)	12·5	7·4	..
	Height	5·3	7	..	..	..	..	..
	Breadth Index . . .	108·6	104·1	..	128·5 (?)	114·7	110·9	..
Pm^4	Length]	6·6	..	..	..	7·5	4·5	..
	Breadth	9·7	..	..	..	11·8	7·0	..
	Height	5·5	..	..	..	..	..	..
	Breadth Index . . .	146·9	..	..	..	157·3	155·5	..
Pm^3	Length	7·0	..	..	..	..	4·5	..
	Breadth	9·5	..	..	..	..	6·0	..
	Height	6·2	..	..	..	..	..	..
	Breadth Index . .	135·7	..	..	..	..	133·3	..

anthropoid upper molars and premolars.

—		Simia satyrus.	Gorilla savagei.	Hylobates leuciscus.	Hylobates agilis.	Anthropopithecus niger.	Pithecanthropus erectus.	Man.
M^3	Length	12·6	14	5·2	4·5	9·7	11·3	8·6
	Breadth	14·8	15·7	6	5·2	10·9	15·3	10·6
	Height	..	..	..	..	..	..	6·3
	Breadth Index	117·5	112·1	115·4	115·5	112·4	135·3	123·3
M^2	Length	14·0	16·7	6·5	6·5	11·0	12·0	9·2
	Breadth	15·8	16·6	7·1	6·4	11·4	14·0	11·5
	Height	..	..	..	..	..	..	7·2
	Breadth Index	112·9	99·4	109	98·4	103·6	116·6	125
M^1	Length	14·7	14·8	6·1	6·5	10·8	..	10·7
	Breadth	14·8	15·4	6·5	6·0	11·4	..	11·8
	Height	..	..	..	..	..	..	7·7
	Breadth Index	100·7	104·2	106·5	92·3	105·5	..	110·3
Pm^4	Length	*10·0	†11·6	4	4	‡6·4	..	6·8
	Breadth	13·1	15·2	5	5	10·3	..	8·8
	Height	9·7	9·7	..	..	..	..	7·5
	Breadth Index	131·0	131·0	125·0	125·0	160·9	..	129·4
Pm^3	Length	11·5	11·7	4	5·0	8·3	..	7·2
	Breadth	12·7	15·5	5	4·5	9·8	..	9·1
	Height	10·5	12·2	..	..	..	..	8·2
	Breadth Index	110·4	132·5	125·0	90·0	118·1	..	126·4

---

* From a skull in the Indian Museum (No. 4 *b*), the type of *Simia brookei*, Blyth, Jour. As. Soc. Bengal, XXII (1853), Pl. I, II.

† Ind. Mus. No. 184.

‡ Ind. Mus. No. 7587.

Table of dimensions and breadth indices of

—		Dryopithecus punjabicus.	Dryopithecus chinjiensis.	Dryopithecus giganteus.	Dryopithecus fontani (Saint Gaudens).	Dryopithecus fontani (Lérida).	Dryopithecus darwini.	Dryopithecus rhenanus.	Dryopithecus rhenanus.	Eoanthropus dawsoni.
M_3	Length	12·5	14·7	19·1	12·5	11·5	13·5	13·0	11·8	11(?)
	Breadth	10·4	12·7	15·3	10·5	9·5(?)	11·8	10·5	9·8	..
	Height	6·7	7·6	8·5	..	..	5·0	4·0	..	..
	Breadth Index . . .	83·2	86·4	80·1	84·0	82·7	87·4	80·8	83·0	..
M_2	Length	11·6	..	..	12	11	..	10·6	10·0	12
	Breadth	9·9	..	..	10·5	9·5(?)	..	9·2	8·4	10
	Height	5·4	..	..	..	..	..	4·8	..	..
	Breadth Index . . .	85·3	..	..	87·5	86·3	..	86·8	84·0	83·3
M_1	Length	..	..	..	10	10	..	9·5	11·2	11·5
	Breadth	..	..	..	10·5	9(?)	..	8·8	9·5	9·5
	Height	..	..	..	..	..	..	4·0	..	..
	Breadth Index . . .	..	..	..	105	90	..	92·6	84·8	82·6
Pm_4	Length	..	..	..	9	..	..	..	..	..
	Breadth	..	..	..	8	..	..	..	..	..
	Height	..	..	..	..	..	..	..	..	..
	Breadth Index . . .	..	..	..	88·8	..	..	..	..	..
Pm_3	Length	..	..	..	10	..	..	..	..	..
	Breadth	..	..	..	8	..	..	..	..	..
	Height	..	..	..	..	..	..	..	..	..
	Breadth Index . . .	..	..	..	80·0	..	..	..	..	..

anthropoid lower molars and premolars.

—		Sivapithecus indicus.	Pliopithecus antiquus.	Propliopithecus hæckeli.	Neopithecus brancoi.	Simia satyrus.	Gorilla savagei.	Hylobates leuciscus.	Hylobates agilis.	Anthropopithecus niger.	Man.
M_3	Length . . .	14·3	7·5	5·3	10·3	14·6	16·2	5·9	5·5	11·6	10·7
	Breadth . . .	13·4	6·0	4·5	7·8	12·8	14·0	5·2	6·0	10·0	9·8
	Height . . .	7·3	..	2·8	5·3	..	..	..	..	..	8·7
	Breadth Index . .	93·7	80·0	84·9	75·7	87·7	86·4	88·1	109·0	86·2	91·6
M_2	Length . . .	13·0	7·3	5·5	..	15·5	16·0	6·7	6·8	12·0	10·7
	Breadth . . .	12·3	6·0	5	..	13·9	14·6	5·6	6·0	11·2	10·1
	Height . . .	7·2	..	3	..	..	..	..	..	..	6·9
	Breadth Index . .	94·6	82·2	90·9	..	90·0	91·3	83·6	88·2	93·3	94·4
M_1	Length . . .	11·5	6·2	5·2	..	12·8	15·3	6	6·5	11·4	11·2
	Breadth . . .	10·6	5·5	5	..	11·8	13·5	5	5·5	10·3	10·3
	Height . . .	6·2	..	3·2	..	..	..	..	..	..	7·7
	Breadth Index . .	92·1	88·7	96·1	..	92·2	88·2	83·3	84·0	90·3	92
Pm_4	Length . . .	8·5	5·0	4	..	10·3	†11·7	4	5·5	‡6·9	7·1
	Breadth . . .	9·9	5·0	4·2	..	10·5	12·4	4	4·0	8·7	8·0
	Height . . .	6·5	..	3·5	..	..	..	..	..	..	7·9
	Breadth Index . .	116·5	100·0	105·0	..	102·0	105·9	100	72·7	126·1	112·7
Pm_3	Length . . .	12·8	6·0	4	..	10·4	13·4	5·8	7·0	9·2	6·9
	Breadth . . .	14·1	4·5	4	..	10·8	13·0	4·0	4·0	7·9	7·7
	Height . . .	..	..	4	..	..	..	..	..	..	7·8
	Breadth Index . .	110·1	75·0	100·0	..	103·8	97·0	68·9	57·1	85·8	111·6

† Ind. Mus. No. 184.
‡ Ind. Mus. No. 7587.

Table of ratios of lengths of last two Molars of Anthropoids.

—	Length of $m_3 \times 100$ / Length of m_2	Length of $m^3 \times 100$ / Length of m^2
Dryopithecus punjabicus	107·7	90·6(?)
Dryopithecus fontani (Saint Gaudens)	104·1	..
Dryopithecus fontani (Lérida)	104·5	..
Sivapithecus indicus	110·0	..
Palæopithecus sivalensis	..	86·6
Propliopithecus haeckeli	96·4	..
Pliopithecus antiquus	110·1	92·8
Simia satyrus	94·2	90·0
Gorilla savagei	101·2	83·8
Hylobates leuciscus	88·1	80·0
Hylobates agilis	80·9	69·2
Anthropopithecus niger	96·7	..
Eoanthropus dawsoni	91·7 (?)	..
Man	100·0	93·5

EXPLANATION OF PLATES.

PLATE I.

FIG. 1.—*Cercopithecus* (?) *asnoti* Pilg. right maxilla with m^1 and mm.^{4} 1 side view, 1a surface view ×2. From the Middle Siwaliks of Hasnot, Punjab (Ind. Mus. D. 12) Page 3

FIG. 2.—*Cercopithecus* (?) *asnoti* Pilg. last upper premolar developed out of the specimen in fig. 1, 2 side view, 2a surface view ×3.

FIG. 3.—*Cercopithecus* (?) *asnoti* Pilg. left maxilla with mm^3 and mm^4, 3 side view, 3a surface view ×2. From the Middle Siwaliks of Hasnot, Punjab (Ind. Mus. D. 121) Page 4

FIG. 4.—*Macacus* (?) cf. *sivalensis* Lydekker right mandibular ramus with m_1 and m_2 4 side view, 4a surface view ×3. Form the Middle Siwaliks of Hasnot, Punjab (Ind. Mus. D. 184) Page 6

FIG. 5.—*Dryopithecus punjabicus* Pilg. right mandibular ramus with m_3 and the broken m_2 5 surface view, 5a side view, natural size, 5b m_3 in the same specimen ×3. From the Lower Siwaliks of Chinji, Salt Range (Ind. Mus. D. 118) Page 9

FIG. 6.—*Dryopithecus punjabicus* Pilg. left mandibular ramus of the same individual with m_2 and the broken m_3, 6 surface view, 6a side view of m_2 in this specimen, natural size. From the Lower Siwaliks of Chinji (Ind. Mus. D. 119) Page 9

FIG. 7.—*Sivapithecus indicus* Pilg. last right lower molar, surface view, natural size. From the Lower Siwaliks of Chinji (Ind. Mus. D. 176) Page 39

FIG. 8.—*Sivapithecus indicus* Pilg. right mandibular ramus with m_2 to pm_4 and the broken m_3 pm_3 and the edge of the alveolus of the canine, 8 surface view, 8a side view from the outside, 8b side view from the inside, natural size, 8c m_2 in the same specimen ×3. [*f*= mental foramen] From the Lower Siwaliks of Chinji (Ind. Mus. D. 177) Page 34

FIG. 9.—*Sivapithecus* cf. *indicus* Pilg. right front lower premolar, 9 surface view, 9a external side view, 9b back view, all figures × 2. From the Nagri zone of Haritalyangar, Belaspur state, Simla Hills. (Ind. Mus. D. 190.) Page 45

PLATE II.

FIG. 1.—*Sivapithecus* cf. *indicus*, Pilg. left half of the mandibular symphysis with the canine and the roots of two incisors and of the front premolar, 1 surface view, 1a front view, 1b back view, 1c outer side view, 1d inner side view, all natural size. [*ar*=front root of pm_3 *pr*=hinder root of pm_3] From the Nagri zone at Haritalyangar, Belaspur state, Simla Hills. (Ind. Mus. D. 189.) Page 42

FIG. 2.—*Sivapithecus indicus* (?) left maxilla with two front molars, surface view natural size, from the Nagri zone of Haritalyangar, Belaspur state, Simla Hills. (Ind. Mus. D. 191.) Page 47

FIG. 3.—*Sivapithecus indicus*, (?) left upper canine, 3 external view, 3a front view, 3b back view, 3c internal view, all natural size, from the Lower Siwaliks of Chinji. (Ind. Mus. D. 192) Page 47

FIG. 4.—*Dryopithecus punjabicus* Pilg. left front upper molar, surface view ×3. From the Lower Siwaliks of Chinji. (Ind. Mus. D. 187) Page 22

FIG. 5.—*Dryopithecus cf punjabicus* Pilg. last left upper molar, surface view ×3. From the Lower Siwaliks of Chinji. (Ind. Mus. D. 186) Page 23

FIG. 6.—*Dryopithecus chinjiensis* n. sp. last left lower molar, surface view natural size. From the Lower Siwaliks of Chinji (Ind. Mus. D. 179). Page 25

FIG. 7.—*Dryopithecus chinjiensis* n. sp. first left lower molar, surface view natural size. From the Lower Siwaliks of Chinji (Ind. Mus. D. 180) Page 26

FIG. 8.—***Dryopithecus giganteus*** **n. sp. last right lower molar, surface view ×2. From the base of the Middle Siwaliks near Alipur, Bakrala ridge (Ind. Mus. D. 175)** Page **27**

FIG. 9.—***Palæosimia rugosidens*** **n. gen. n. sp. last right upper molar, surface view ×3. From the Lower Siwaliks of Chinji. (Ind. Mus. D. 188)** **Page 29**

PLATE III.

FIG. 1.—***Dryopithecus*** *punjabicus* **Pilg. right maxilla with m_2, m_1, pm_4 and pm_3, surface view ×3. From the Nagri horizon of the Middle Siwaliks at Hari Talyangar, Belaspur state, Simla Hills. (Ind. Mus. D. 185)** Page **16**

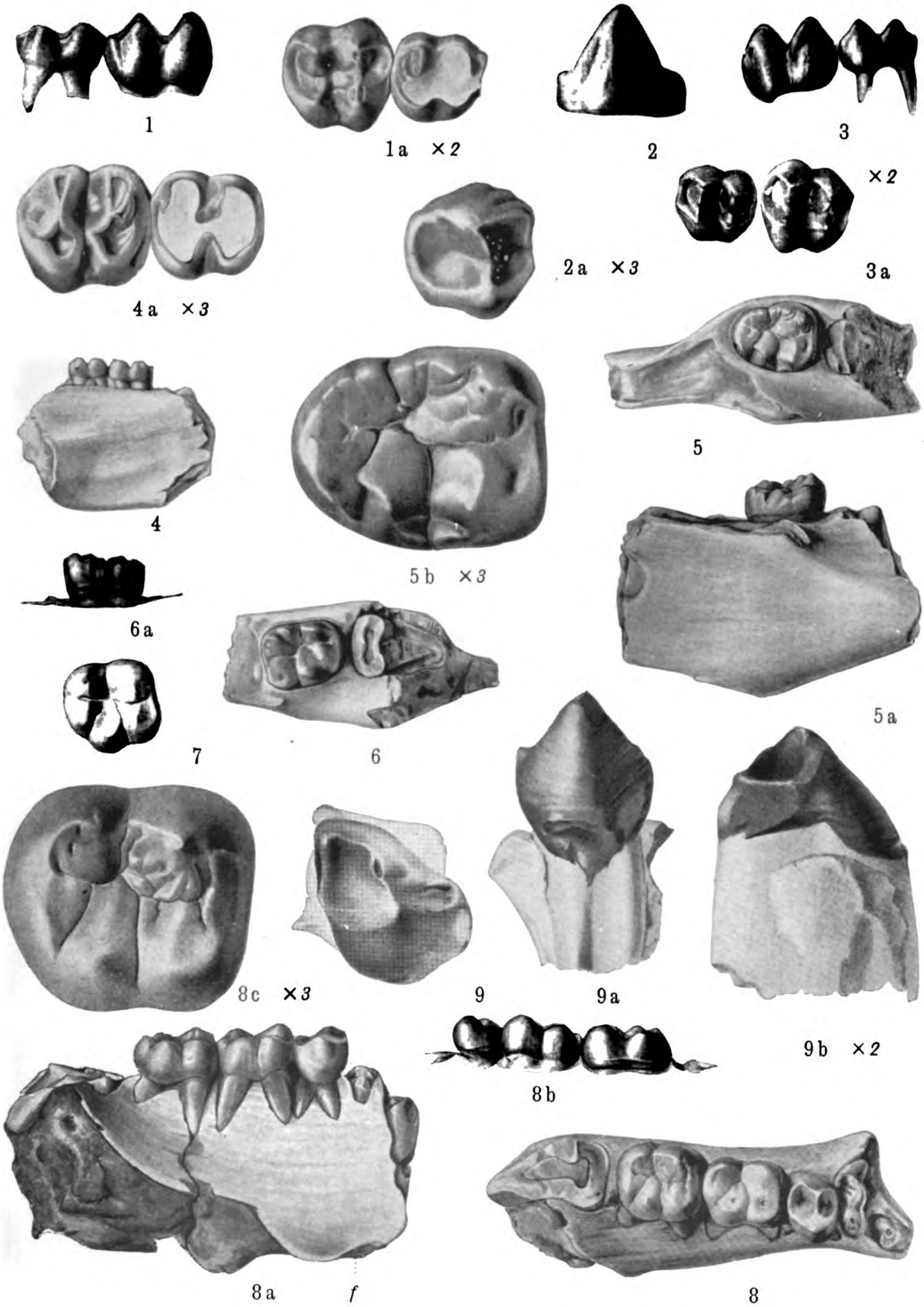
FIG. 2.—***Dryopithecus*** *punjabicus*, Pilg. same maxilla, side view ×3.

PLATE IV.

TABLE showing the suggested evolution of the Anthropoid apes and Man.

GEOLOGICAL SURVEY OF INDIA.

Records, Vol. XLV, Pl. 1.

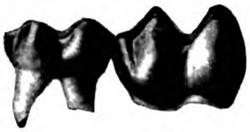


G. M. Woodward and S. N. Guine, del.
(Figs. 1—8) (Figs. 9, 9a, 9b.)

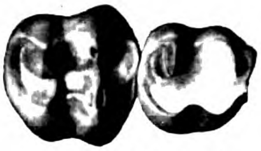
G. S. I. Calcutta.

NEW SIWALIK PRIMATES.

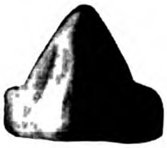
All figures natural size except otherwise indicated.



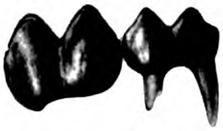
1



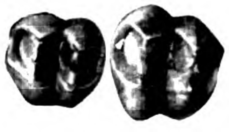
1a ×2



2

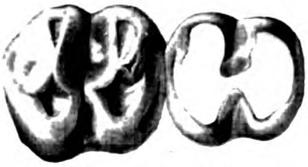


3

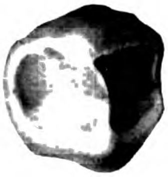


×2

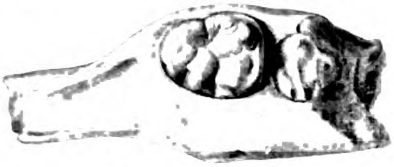
3a



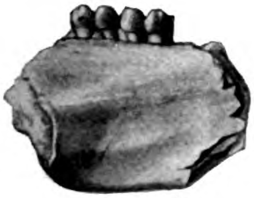
4a ×3



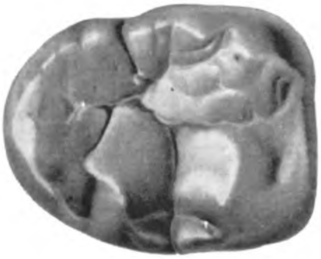
2a ×3



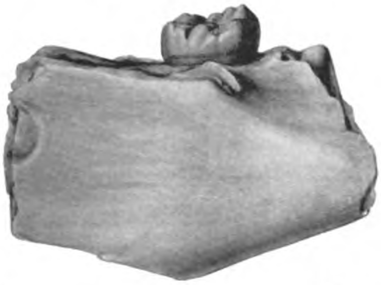
5



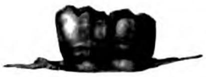
4



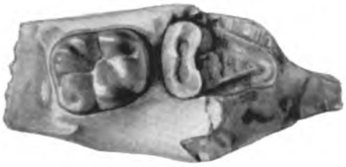
5b ×3



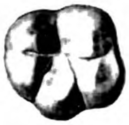
5a



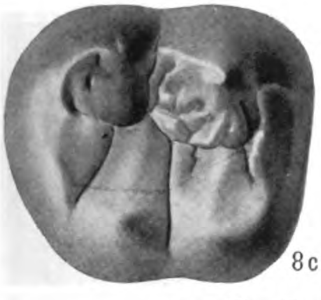
6a



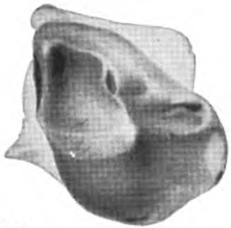
6



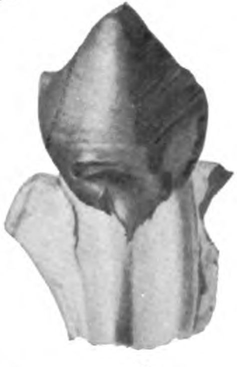
7



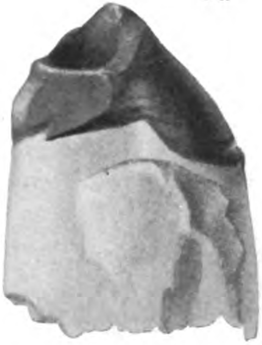
8c ×3



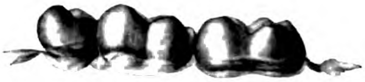
9



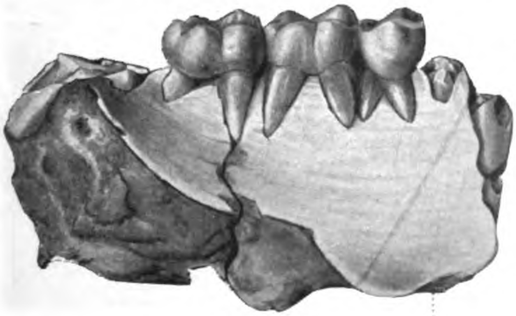
9a



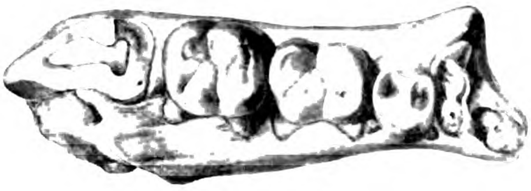
9b ×2



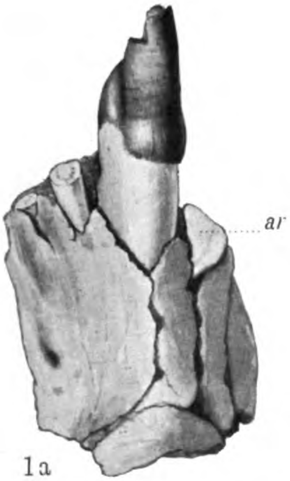
8b



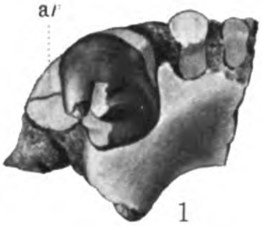
8a



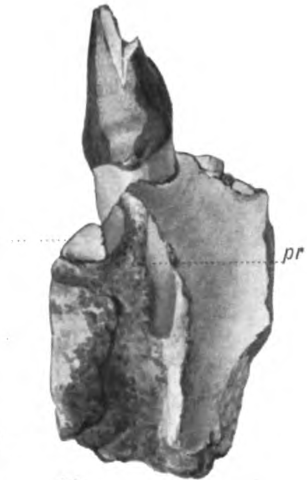
8



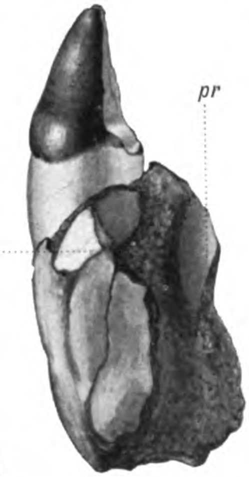
1a



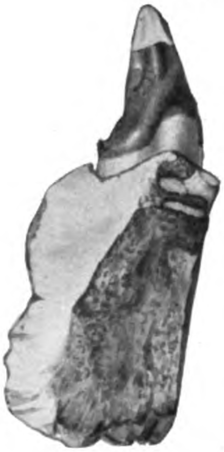
1



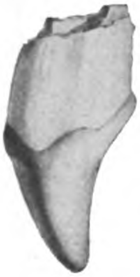
1b



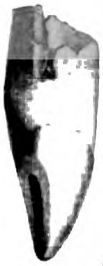
1c



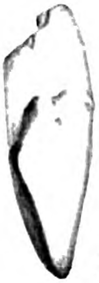
1d



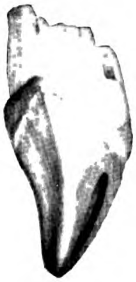
3



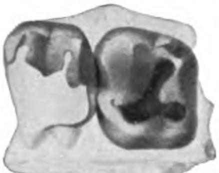
3a



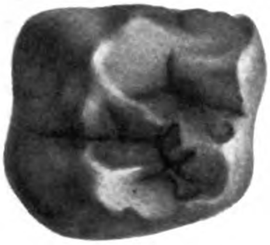
3b



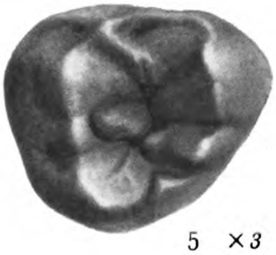
3c



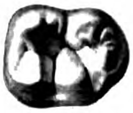
2



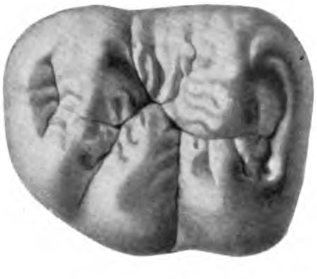
4 ×3



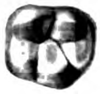
5 ×3



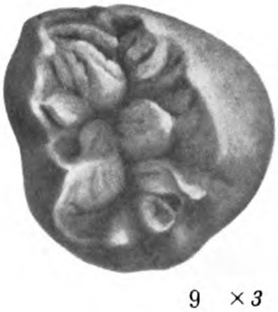
6



8 ×3



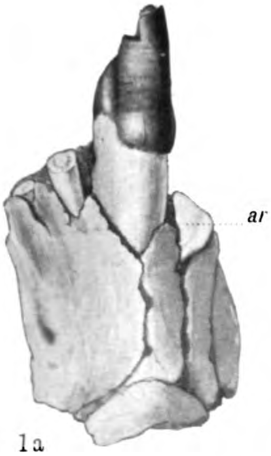
7



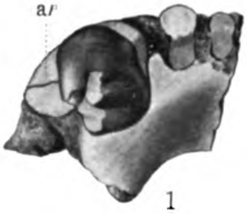
9 ×3

GEOLOGICAL SURVEY OF INDIA.

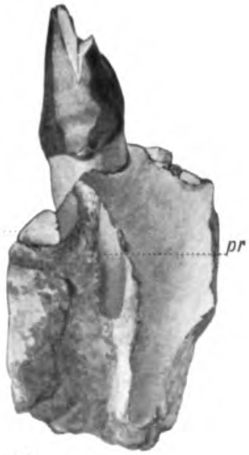
Records, Vol. XLV, Pl. 2.



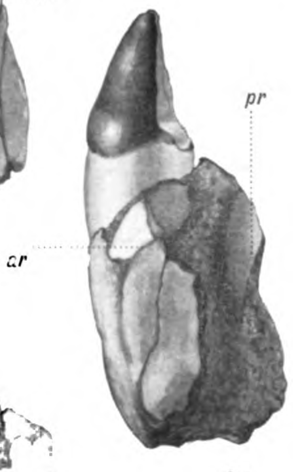
1 a



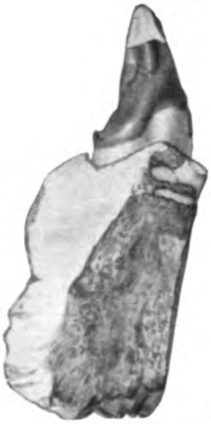
1



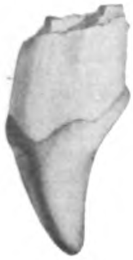
1 b



1 c



1 d

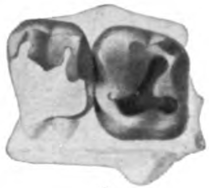


3

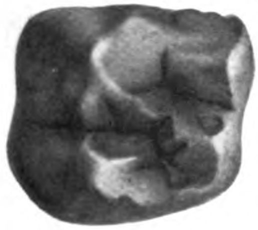
3 a

3 b

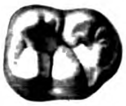
3 c



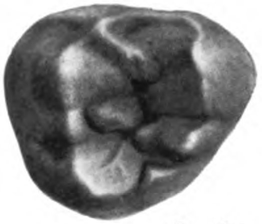
2



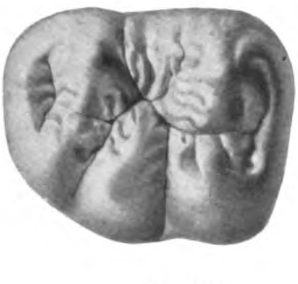
4 ×3



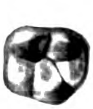
6



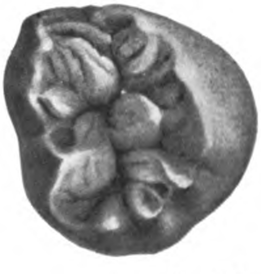
5 ×3



8 ×3



7



9 ×3

G. M. Woodward and S. N. Guine, del. (Figs. 6—8) (Figs. 1—5 & 9.)

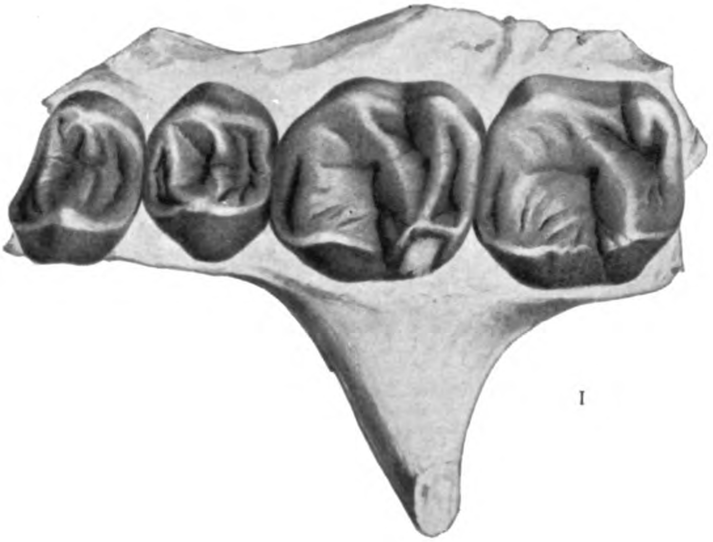
G. S. I. CALCUTTA.

NEW SIWALIK PRIMATES.

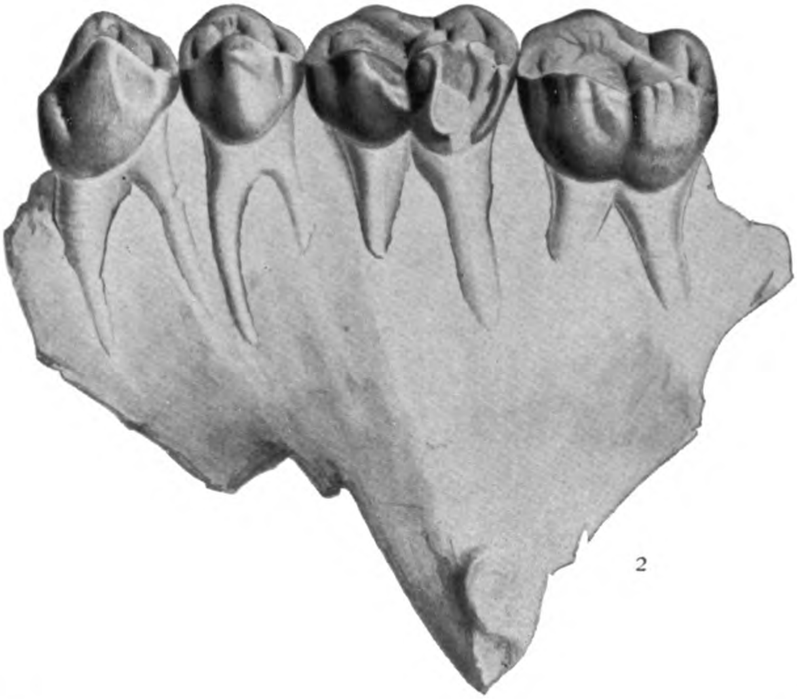
All figures natural size except otherwise indicated.

GEOLOGICAL SURVEY OF INDIA.

Records, Vol. XLV, Pl. 3.



1



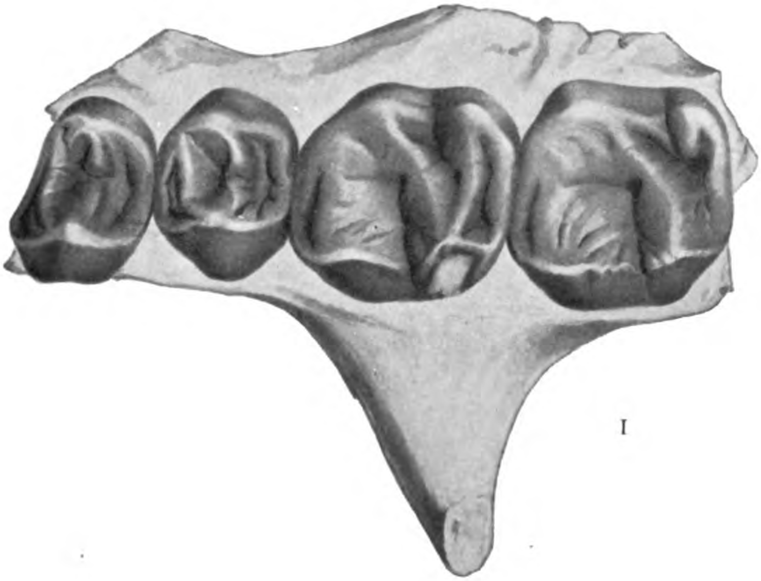
2

S. N. Guine, del.

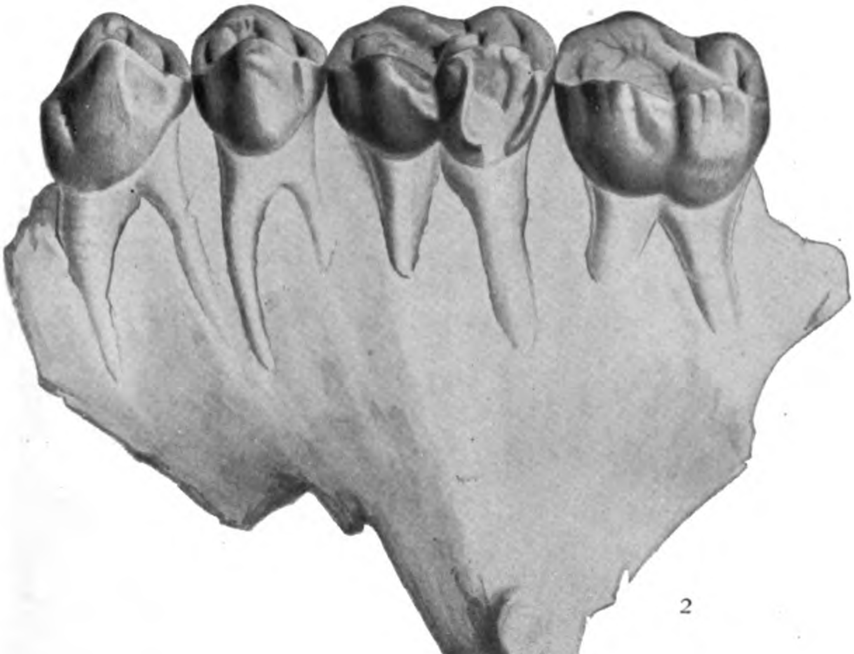
G. S. I. Calcutta.

NEW SIWALIK PRIMATES.

(enlarged three times natural size.)



I

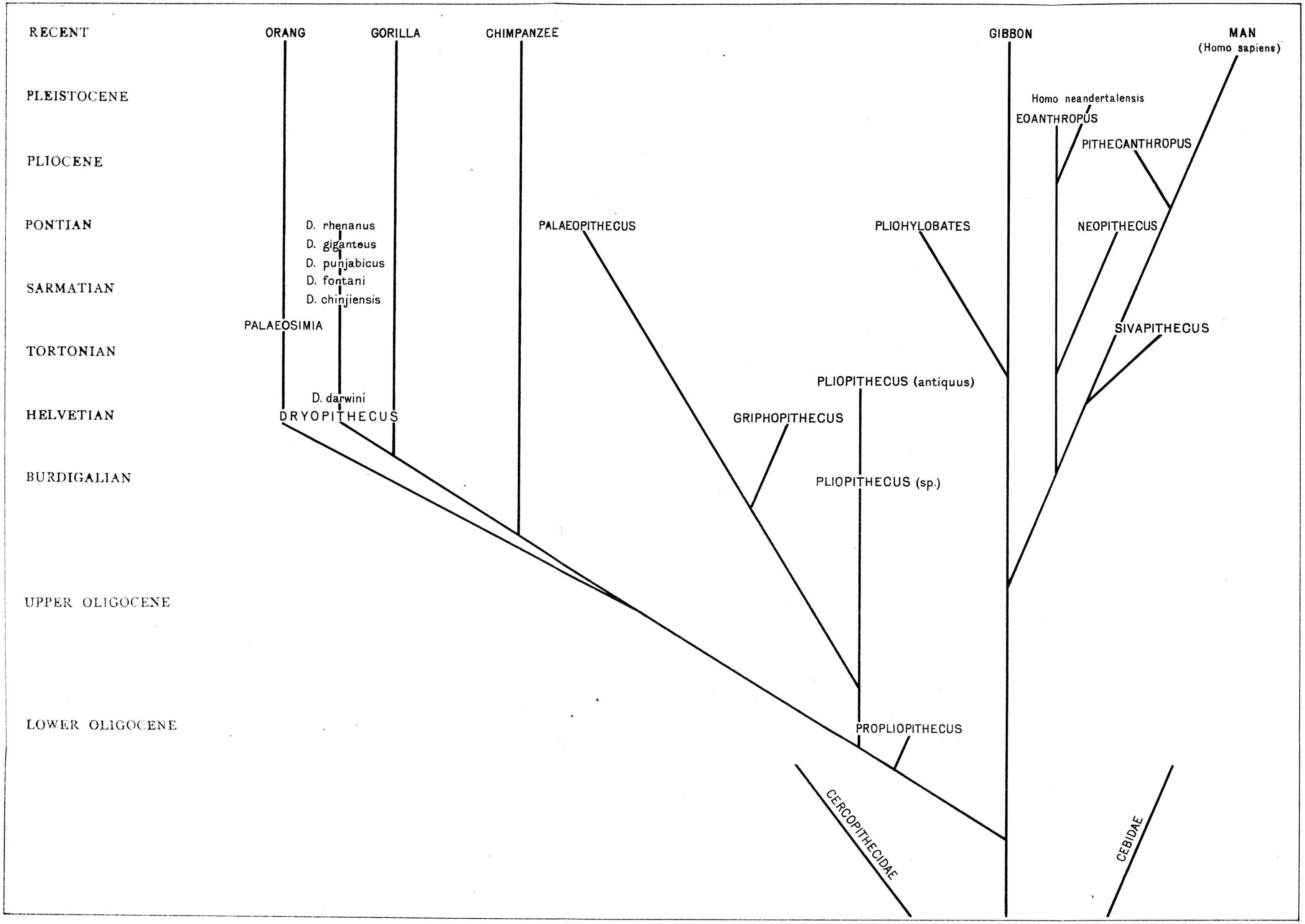


2

S. N. Guine, del.

G. S. I. Calcutta.

NEW SIWALIK PRIMATES.



C. S. I. Calcutta.

SUGGESTED EVOLUTION of MAN and the ANTHROPOID APES.